MOUNTAINTOP REMOVAL AND VALLEY-FILL MINING ENVIRONMENTAL IMPACT STUDY

BIRD POPULATIONS ALONG EDGES REPORT FOR TERRESTRIAL STUDIES

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Introduction

Problem Statement

Mountaintop mining is a method of removing soil and rock to expose multiple coal seams. Valley fills are produced when earth and rock, extracted from a mountaintop mining site, are placed into an adjacent valley. Mountaintop mining, like contour mining and logging activity, creates considerable edges and patchy habitats. The impacts of edges and patch size and type produced by mining activity are largely unknown. Despite a large number of avian edge studies in forest-dominated landscapes, studies in mine-altered landscapes are scarce. Likewise, recent effort has focused on breeding bird communities without much attention directed to avian stopover ecology and migration and relative abundance during the winter months. Because of increasing size of mountaintop removal/valley fill (MTRVF) operations as well as in the number of mining permit applications, West Virginia may continue to become increasingly fragmented. For example, there were at least 26 permits issued for operations on Kayford Mountain from 1971-1983 and at least 70 mountaintop removal permits issued since 1970. Although suburban sprawl and other factors contribute to forest fragmentation and edge effects, MTRVF has generated considerable concern as to whether it contributes to the commonplace phenomenon of edge effects. Edge effects include increased rates of nest parasitism by cowbirds, nest depredation, and changes in population structure. In this study, we quantified avian diversity and relative abundance along four treatment habitats. Habitats studied were young (grassland) reclaimed mines, older (shrub/pole) reclaimed mines, fragmented forests, and relatively large (intact) forests. Specifically, we sampled birds along ecotones where two treatment habitats joined and compared avian abundances in edge and interior habitats in contour and MTRVF mines. Data were collected in spring, summer, fall, and winter months in order to examine seasonal changes in avian species composition across treatment habitats.

Background and Justification

Edges or ecotones can be defined as areas created by the juxtaposition of distinctly different habitats or as zones of transition between habitat types (Ricklefs 1979). There is a tendency for increased variety and density of organisms at habitat junctions (Odum 1971, Alverson et al. 1988, Reese and Ratti 1998, Robinson 1988, Yahner 1988). During the last several decades, researchers have collected evidence that edge or ecotone habitats generally harbor higher avian diversity than interior forests. Others argue that edge populations are sinks, where reproductive output is inadequate to maintain local population levels. Sink populations must be replenished by emigration from source populations. However, most studies in forest-dominated areas have not documented a relationship among sink populations, nest predation, and edges (Yahner and Wright 1985, Small and Hunter 1988, Storch 1991, Rudnicky and Hunter 1993, Haskell 1995, Hanski et al. 1996). A few researchers have found higher nest predation and cowbird parasitism along edges (Brittingham and Temple 1983, Gates and Gysel 1978, Chasko and Gates 1982, Wilcove 1985, Martin 1988, Small and Hunter 1988, Robinson et al. 1995). Apparently, variation exists across edge types and spatial and temporal patterns.

Landscapes across the world are highly fragmented with little interior forests remaining, except for a few places such as eastern North America (Riitters et al. 2000). Clearly, many problems arise because of the variation in types (and causes) of fragmentation and the definition of forest (by size, vegetation, etc.). Nevertheless, studies of the effects of forest fragmentation on breeding birds have suggested that some bird species are sensitive to a reduction in forest area (e.g., see Whitcomb et al. 1981, Robbins et al. 1989). We know that many species of songbirds are declining (e.g., see Askins et al. 1990). This is true of both forest-interior and open-country species. Some specialists, however, argue that many forest species have recovered (from declines that probably started in the 1960s) with advancing forest regeneration in the Eastern U.S., and that we should therefore be more concerned with the sharp declines of many grassland and shrub/edge species (Hill and Hagan 1991, Peterjohn and Sauer 1994a and 1994b, Thomas and Martin 1996, Sauer et al. 2000). For example, data from the North American Breeding Bird Survey (BBS) indicate that populations of the Dickcissel and Henslow s Sparrows have declined by about 39% and 91%, respectively, during the last 30 years (Peterjohn et al. 1994b, Pruitt 1996, Herkert 1997). Hunter et al. (2001) documented that none of the 60 species of eastern, forest-associated landbirds are considered vulnerable in eastern North America at this time, and that only two non-disturbance dependent forest species (Bicknell s Thrush and Prothonotary Warbler) are on the Watch List. The Watch (Blue) List is a National Audubon Society and American Bird Conservancy documentation of avian species in rapid decline and before they are federally listed as threatened or endangered (Arbib 1971, Tate 1981, 1986, Ehrlich et al. 1988, Carter et al. 1996, Pashley et al. 2000). Of the 60 avian species in eastern North America that are not dependent upon disturbance, only 15% are declining. Therefore, Hunter et al. (2001) focused their attention on the rapid declines of grassland and shrubland birds (disturbance-dependent species). Studies show that Eastern North America had considerable pre-colonial shrub habitat and that many localized areas supported extensive areas of secondary succession (Litvaitis et al. 1999, Askins 2000, Hunter et al. 2001). Consequently, the prevailing view of the Eastern deciduous forest as the exclusive pre-colonial habitat is unfounded (Day 1953, Litvaitis et al. 1999), and the disappearance of shrub/grassland birds in the eastern U.S. is of great concern.

Despite the concern over disturbance-dependent species, many researchers have focused attention on forest-interior species in areas such as West Virginia, where large tracts of forest remain that harbor potentially viable source populations for species such as the Cerulean Warbler and Wood Thrush. A number of mature forest-associated species are dependent upon some disturbance that maintain small openings and are declining (W. Hunter, pers. comm.), and some argue that the forest-dwelling, short-distance migrants are no longer doing better than long-distance forest migrants (J. Confer, pers. comm., Sauer et al. 2001).

Mountaintop removal and valley fill mining creates grasslands and forest fragments of various sizes and degrees of isolation, in addition to a mosaic of edge types. As a consequence, species richness and abundance within different trophic assemblages may vary with forest size and structure (e.g., see Martin 1981). Some forest-interior species require a minimum forested area, while others (e.g., shrub guild) expand in number in patchy, fragmented habitat with increasing edge. Small patches of forest consist of mainly edge habitat (Forman and Godron 1981) and are dominated by birds that feed on a wide variety of food items along the edge (Martin 1981). Forest edge often supports a greater diversity and abundance of food than does forest interior (Ranney et al. 1981, Lovejoy et al. 1986, Fowler et al. 1993, but see Burke and Nol 1998, Robinson 1998), which may favor short-distance migrants at the expense of foliage insectivores. Foliage insectivores are predominantly long distance-migrants and many prefer large tracts of forest (Whitcomb et al. 1981). Thus, habitat change, such as that induced by MTRVF, is likely to produce trade-offs between forest-interior species (many of which are Neotropical migrants) and grassland/shrub guild birds (many of which are short-distance migrants or resident species). However, long-term studies on mine lands in secondary succession in southern West Virginia suggest that secondary succession occurs faster than predicted on contour mines and that edges created by mineland are, in fact, more diverse in avian species richness and abundance than interior forest (Canterbury et al. 1996, Canterbury and Stover 1999, Stover and Canterbury, in press). These contour mines were created by cutting into the hillsides and creating a level bench with highwalls. These studies further demonstrated that edge and shrub species occur in the same general area and territories as forest-species, and that the relative abundance of both groups is exceptionally high for short periods of time (up to 20 years after reclamation).

In this study, we test whether there is an edge effect, i.e., whether avian population structure is drastically altered by MTRVF induced-habitat changes. Specifically, we test for a relationship between avian species richness or density and edge, and whether there is a trade off between forest-interior species and disturbance-dependent (grassland and shrub-guild) birds? To determine the impact mountaintop mining on avian abundances along a mosaic of edge habitats, we quantify bird-habitat associations along edge habitats produced by MTRVFs and compare avian abundances at edges and interior plots throughout mine sites in southern West Virginia.

Many previous studies of birds on mine lands were conducted during the breeding season and often did not stress migration and winter season bird-habitat associations (see Brewer 1958, Yahner and Howell 1975, Chapman et al. 1978, Whitmore and Hall 1978, Allaire 1979, 1980, Whitmore 1979, 1980, Strait 1981, LeClerc 1982, Wray et al. 1982). We know very little about the impacts of edges on avian migration and stopover ecology and winter ecology. What avian species are using edge habitats of MTRVF in winter and migration periods? A major objective of this study was to assess seral and edge stage variation in bird distributions along mountaintop mine sites and intact forest watersheds during the winter and migration periods.

Winter is a time when populations are resident and relatively stable, and thus, provide important data on survivorship and interpretation of population trends (e.g., see Robbins 1981, Yahner 1993). Survivorship is highly dependent upon successful migration and/or winter ecology (Stearns 1992). Migration is also a critical time in the lives of migratory birds, especially the Nearctic-Neotropical migrants that breed in temperate North American and spend their winter in Central and South America. Neotropical migrants must find adequate fueling and shelter areas during migration and, thus, a changing landscape pattern may prove detrimental to their survival.

Stopover ecology of migrant landbirds is a pressing environmental issue, since many key stopover areas in North America have been degraded or destroyed by suburban sprawl and development. Consequently, monitoring programs have generally focused on delineating migration pathways and critical stopover habitats (Moore et al. 1990, Wilson et al. 2000). Studies of avian migration biology in West Virginia and throughout the Eastern U.S. have disclosed some interesting phenomena and trends. First, it is clearly documented that a substantial amount of shrub habitat in a mosaic of forests is needed for migrant landbirds (Hall 1999). This would implicate older (shrub/pole succession) mountaintop and contour mines as potentially important habitats for avian stopover. On the other hand, there may also be a need for forested ridgetop habitat where significant migratory flights occur. This latter type of habitat is where most migrants are captured for banding within the state at our two major banding stations (Allegheny Front Migration Observatory or AFMO in Grant County, and Three Rivers Migration Observatory or TRMO in Raleigh County).

Avian migration biology has been traditionally documented by labor-intensive mist-netting and bird banding (e.g., Winker et al. 1992, Morris et al. 1994), which is one of the most robust methods for determining species richness and abundances as well as estimating population trends (Karr 1981, Williams et al. 1981, Conner et al. 1983, Hagan et al. 1992, Rappole et al. 1993, Buckley et al. 1998). However, less labor-intensive methods (e.g., those that rely on count surveys) are often also employed. The line transect method of counting birds, for example, is one of the most frequently used and accurate assessment techniques to assess bird populations. The ecological literature on line transect methods is enormous. The line transect method is often employed in open terrain, but is also used along forest trails. Line transects in forested landscapes have been shown to be more useful for monitoring spring migrants than point counts (Wilson et al. 2000). Variable size transects are often employed in research protocols and include, for example, 100, 250, and 400 meter length transects (see Ralph et al. 1993 and Wilson et al. 2000).

Therefore, another objective of this study was to quantify avian relative abundances along transects during the spring and fall migration seasons at MTRVF sites. The study will serve as an indicator of which bird species are utilizing MTRVFs, but should not serve as a replacement for long-term bird-banding studies (see Canterbury and Stover 1998, Hall 1999). This is especially important since substantial between-year variation exists in migration patterns, as well as significant species-specific, temporal, and spatial variation in avian migration ecology.

Historical Perspective

In the late 1980s, studies suggested that forest-dwelling Neotropical migrants were in widespread decline (e.g., Terborgh 1989). Studies that now encompass a longer time span suggest that these early warnings were overstated. After decades of analyses, a much different, albeit murkier, overall picture for forest birds indicates that their populations are in relatively good shape. Overall populations of many forest dwelling species are stable or increasing (Rosenberg et al. 1999a, 1999b, Sauer et al. 2000), while grassland-dwelling birds tend to be worse-off (Knopf 1994, Herkert et al. 1993, Vickery and Herkert 1999, Sauer et al. 2000). Grassland bird populations have shown steeper, more consistent, and more geographically widespread declines than any other avian guild in North America (Knopf 1994, Ruth 1996, Askins 2000). BBS data from 1966-1993 show that almost 70% of the 29 grassland bird species had negative population trends (Peterjohn et al. 1994, Hunter et al.

2001). Grasshopper Sparrows have declined by nearly 70% during the past 25 years (average of 6% decline per year), while the Eastern Meadowlark is down 43% (Peterjohn et al. 1994).

Avian composition is noted to change with advancing secondary succession (Bock et al. 1978). Grassland birds distribute vertically in feeding height and horizontally by habitat preference (Cody 1968). Forest species are known to show vertical and horizontal distribution along a continuum from forest edge to mature forest (James 1971), while old field birds are known to be scattered along a cline in shrubbiness habitat (Posey 1974). Vegetation-bird associations of grassland birds are fairly well studied (e.g., Grzybowski 1983, citations in Swanson 1996). However, grasslands are considered by many to be the most endangered ecosystem worldwide (Herkert et al. 1993, Samson 1998) and support a group of birds whose distributions are not centered in heavily forested states (e.g., Pennsylvania, Gross in Crossley 1999). Some heavily forested states (e.g., West Virginia), and states with little forest cover (e.g., Ohio) have both experienced drastic declines of species such as the Bobolink and Henslow s Sparrow. The Henslow s and Bachman s sparrows, for example, have been nearly extirpated from West Virginia as breeding birds (Buckelew and Hall 1994, Canterbury, unpubl. data).

Population trends vary in space and time and much contradictory information exists. For example, the East Coast and Midwest have suffered significant forest bird losses, while bird populations in some Appalachian forests have been maintained or increased. Variation in avian population structure exists, where some forest-dwelling species are doing well in the Allegheny Plateau and Ohio Hills, but declining in the Southern Blue Ridge (W. Hunter, pers. comm.). The Cerulean Warbler has declined by 51% and the Wood Thrush and Eastern Wood-Pewee have declined by 41 and 34%, respectively (Sauer et al. 2000). Others, such as the Scarlet Tanager, show stable populations but significant local declines, such as along the Atlantic Coast (Rosenberg et al. 1999a). A close examination of forest-dwelling species associated with small forest openings and forest edges reveals that 45% of 30 species are undergoing long-term declines or are recently declining in eastern North America (see Table 5, p. 450-451 in Hunter et al. 2001). Conversely, some forest species, such as the Cerulean Warbler, are numerous and probably not declining in parts of West Virginia (see BBS data cited in Buckelew and Hall 1994, Rosenberg and Wells 1995, Rosenberg et al. 2000). West Virginia is the center of abundance for some forest species, such as the Cerulean Warbler and, thus, any manipulation to the forest and forest management practices should be evaluated.

Despite massive habitat changes (e.g., the entire eastern US was heavily logged during the late 1800s and today we are faced with rapid suburban sprawl), many forest species have shown resilience. Adaptation of forest dwelling species to mine-altered lands provides another example of the resilience of forest species (Canterbury and Stover 1999). Although a few eastern species, such as the Ivory-billed Woodpecker, Carolina Parakeet, and the Bachman s Warbler, disappeared, there is now more forest than a century ago and new trouble for the grassland and shrub birds. Advancing succession has favored forest-dwelling species over shrubland birds, but industry practices (logging and mining) have created a mosaic of habitats that can support both shrub and forest species (Canterbury and Stover 1999). The question remains for how long will shrub species, such as the Golden-winged Warbler, continue to thrive in the heavily forested, second-growth areas that dominate our contour mines in southern West Virginia (Canterbury et al. 1993, 1996)? Second-growth forests that may appear good habitat for Golden-winged Warblers, however, may be a trap or sink for forest-dwelling species such as the Cerulean Warbler. Such differences in source and sink populations may explain contradictory data and geographical variation in avian population declines.

The literature is full of papers that show a decline of forest-dwelling species (e.g., Wood Thrush) due to habitat fragmentation produced by agriculture and suburban sprawl (see review by Robinson [1988] and synopsis of Villard [1998]). A comparison of edge types created by mining/logging activity in heavily forested West Virginia with those created by agriculture and suburban sprawl should be made with caution, since these edge types are strikingly different and surrounded by different landscapes. It is not valid to assume that the fragmentation impacts due to mining will mirror those due to agriculture and small, patchy forested landscapes created by sprawl. Data from southern West Virginia suggest that some species of forest bird populations are depressed by increasing sprawl / development and burgeoning deer populations rather than mining and logging activities (Canterbury 1999, Canterbury 2000a, Stover and Canterbury, in press). This may explain why most forest-canopy species, such as the Red-eyed Vireo and Scarlet Tanager, are increasing, while a number of ground and understory nesting songbirds (e.g., Hooded and Kentucky warblers) are declining (Stover and Canterbury, in press).

Substantial research has documented that edge effects depend upon landscape context and percent forest cover in eco-regions (e.g., Appalachian) and that overall landscape must be considered in evaluating impacts of fragmentation (Donovan et al. 1997). Recent approaches have been aimed at forest management for declining songbirds (Thompson et al. 1992, 2000). Most studies that document negative impacts of fragmentation on forest-dwelling birds have been conducted in highly fragmented landscapes with agriculture edges (Herkert 1995, but see Hoover et al. 1995). It remains unknown whether negative effects occur in the highly forested West Virginia landscape with edges created mainly by logging and mining activities. Predation rates are often higher near the forest/farmland edge than in forest interior or large forest tracts (Gates and Gysel 1978, Wilcove 1985, Andrén and Angelstam 1988, Andrén 1992, Angelstam 1992, Hoover et al. 1995), but the same does not apply for edges between forests and clearcuts or edges produced by MTRVFs (Canterbury and Stover, in press). Variation in predation rates and number of predators in rural vs. suburban settings and forest/farmland mosaics exists (Yahner and Morrell 1991, Donovan et al. 1997). This may indicate that the notion of an ecological trap (by attracting birds to establish territories on edges where food supplies may be greater but nest predation is increased) [Gates and Gysel 1978]), may not apply in all fragmented landscapes (Wiens 1995).

A clearer picture about the impacts of MTRVF mining can be drawn if we consider bird populations across a variety of successional stages and edge types and document changes accordingly. Effort should be made try to conserve for the future rather than predict the past (i.e, what birds should be present and in what densities before mining disturbance). Many studies on mine-altered landscapes have compared pre-mined with post-mined lands or fragmented forest tracts with contiguous tracts. Such comparisons are problematic for at least two reasons. These include (1) a continuum of human-induced habitat alterations and (2) the misconception that the pre-colonial eastern landscape was almost entirely forested. Habitats will continue to be altered, whether through suburban sprawl, forestry industry, parks and tourism, agriculture, or even mining. It seems logical to document how birds respond to changing landscapes rather than to try to predict the presence or absence of forest species or document potential declines of forest-interior species in post-mined land as compared to pre-mined.

At the time of arrival of Europeans in North America about 50% (445 million ha.) of the land was forested (Yahner 1995). About three-fourths of this forested land was located in the eastern half of the continent and remained relatively undisturbed until the late 18th century (Rosenberg et al. 1999b). By 1850, an estimated 48 million ha. of forest in the eastern United States was converted to agriculture, and much of the remaining forest land was cut (Rosenberg et al. 1999b). Today, despite extensive fragmentation throughout the eastern U.S., many regions, such as the Appalachians are still heavily forested (Rosenberg et. al. 1999b). West Virginia, like many other areas in the Appalachian Region, is primarily covered in forest (76% of the land cover) and is the third most heavily forested state in the nation (West Virginia Forestry Association, pers. comm.). The amount of land in West Virginia affected by large scale surface coal mining, including mountaintop mining, is small but steadily increasing. Mountaintop removal mining dates back to the early 1970s and Arch Coal, for example, has conducted MTRVF mining since 1975. Since 1977, 0.6% of the total West Virginia land cover has been large scale surface mined (West Virginia Mining and Reclamation Association).

Mountaintop mining is a specific technique of land use that requires forest harvest before coal extraction. The current harvest of trees from West Virginia forests is exceedingly high and based on numerous economic motives. Despite the fact that much of the forest lands in West Virginia have been recently subjected to selective and clear-cutting, forestry practices have not been subjected to similar scrutiny as mining practices. Both logging and mining merit further study on whether they promote the loss of forest-dwelling birds due to fragmentation. Both techniques of mining and logging promote forest disturbance and an increase in gaps and edges. These methods of land use create habitat for shrub/edge species such as the Chestnut-sided and Golden-winged warblers, whose pre-European populations may have been maintained by naturally-induced modes of secondary succession.

Heavily forested states such as Pennsylvania had some open habitats, such as grasslands and old fields, prior to European settlement (Day 1953, Cronon 1983, Williams 1989, Gross in Crossley 1999, Askins 1994, 2000). Prior to European colonization, early-successional and shrub-dominated habitats were widely distributed throughout the northeastern United States (Litvaitis et al. 1999). Fires (including those intentionally set by aboriginal people), wind storms, and especially beavers (*Castor canadensis*) were likely the major forces that set back succession and perpetuated shrub habitats (Litvaitis 1993, Litvaitis et al. 1999, Hunter et al. 2001). These factors promoted the expansion and increase of shrub species, such as the Chestnut-sided Warbler. At present, shrubland birds, such as the Yellow-billed Cuckoo, Golden-winged Warbler, Prairie Warbler, and Field Sparrow are declining (Peterjohn et al. 1994). Only 1 (the Blue Grosbeak) of 16 Eastern shrubland bird species has shown a significant population increase since 1966 (Sauer et al. 2000). Loss of substantial amounts of early successional habitat is widespread, especially evident in the reforested northeastern United States, and has been documented as a major cause of the widespread reduction in shrubland bird species (Hill and Hagan 1991, Witham and Hunter 1992, Litvaitis 1993).

EIS REPORT

In eastern North America, shrub habitat is ephemeral and, if left to succeed, is replaced by forest at variable rates (Confer and Larkin 1998). In New York and West Virginia, for example, early successional fields are dominated by herbaceous growth for about 10-20 years and shrubs are abundant for about 15-30 years after cessation of farming (Confer and Larkin 1998, Canterbury, unpubl. data). Succession after clear-cutting is rapidly dominated by sapling growth (Confer 1998). Pimm and Askins (1995) described the regional shift in farmland abandonment which started in New England and moved westward across the United States with emphasis on local extirpation of both shrub and forest bird species. Although grassland birds as a group are in severe decline, management practices are underway and it is anticipated that the beef and dairy industry will maintain some pasture and hay fields (Confer and Larkin 1998). Despite the creation of successional habitats by these industries, they may not be good for grassland species because of frequent mowing and too much grazing. Similarly, previous declines in some forest-dwelling species have been reversed by advancing reforestation (Confer and Larkin 1998). In contrast, the shrub habitat has no economic incentive for management and the decline in the rate of farmland abandonment (Census of Agriculture 1992) may cause the shrub guild birds to surpass all other guilds in the rate of decline (Confer and Larkin 1998, Litvaitis et al. 1999). Practically, the only management of shrub habitat is usually on state land for game species and utility rights-of-way, which is not enough.

The trade-off between forested and non-forested lands will continue because of human population growth. The US population is currently estimated at 281.4 million (Census Bureau, http://www.census.gov), and increasing rapidly. The burgeoning human population and their destruction of habitats will continue to increase our demand for fuel and anthropogenic changes of the landscape. These pressures will lead to additional fragmentation of the eastern U.S. forests by additional mining and timbering. Therefore, as part of the environmental impact study (EIS), we include some data on a long-term study of birds in the southern West Virginia coalfields. This long-term study may facilitate management plans by providing a clearer picture of bird-habitat associations.

Methods

Study Areas and Selection of Sampling Plots

This research was part of a larger EIS study and a subcomponent of the terrestrial studies. The study areas included three mountaintop mining sites chosen for study by the Environmental Protection Agency (EPA), namely Hobet 21 (Boone County), Daltex (Logan County) and Cannelton (Kanawha/Fayette counties) in southwestern West Virginia. Major watersheds include Mud and Little Coal Rivers (Hobet 21), Spruce Fork (Daltex), and Twentymile Creek (Cannelton). The study areas are in the Allegheny Plateau physiographic province (Hall 1983). The Cannelton mine is approximately 2,474 ha. with 510 hectares (ha.) of shrub/pole habitat, while Daltex is approximately 2,834 ha. with 296 ha. of shrubland and Hobet 21 is about 4,394 ha. with 428 ha. of shrubland (Table 1). These mine sites and associated watersheds surveyed were thoroughly surveyed for availability of edge habitats. Edge habitat categories (treatments) studied corresponded with P. Wood s simultaneous study of interior treatments (grassland, shrubland, forest fragment, and relatively intact forest). However, edge studies precluded any robust selection of relatively intact forest, since the mineland had to abut forest tracts in order to be considered an edge. The following edge-types were studied: (1) intact (large) forest-grassland ecotone, (2) forest fragment (or woody patches)-grassland ecotone, (3) forest fragment-shrub ecotone and (4) shrub-grassland ecotone. These edges selected were comparable in vegetation and age to interior habitat plots chosen by P. Wood, except study points were placed at areas where two habitat types join. Table 2 shows the number of edge habitats studied at each site. Three of these habitat types or treatments (fragmented forest, young reclaimed mine or grassland, and older reclaimed mine or shrub/pole) are the results of mining activities. Intact forest sites are relatively large forest areas undisturbed by mining activities and located in the same watersheds as the mine sites or in adjacent watersheds near the reclaimed sites. These generally consist of large forest lands abutting mine property. Fragmented forest tracts are stands (islands) of small woodlots surrounded by reclaimed mine land and/or ravines with valley fill/overburden. Fragmented forests also included ridges bordered by reclaimed minelands and were typically harvested between 5-30 years ago by selective-cutting.

Intact and fragmented areas consist mostly of relatively mature hardwood trees, including oak species (red, white, black, etc.), hickory species (bitternut, pignut, and shagbark), maples (red and sugar), American sycamore, white ash, and black birch (see Appendix 1). Young reclaimed mine areas consisted mostly of grasses and were less than 20 years of age. These grasslands varied in slope and some areas were terraced. Tall fescue, sericea, autumn olive, black locust, European black alder, and pines (mainly Virginia pine) dominated young reclaimed habitat. Older reclaimed mine areas contained shrub and pole-size vegetation of approximately 10-32 years in age. Much of the older reclaimed areas, especially on Cannelton mine, were created by contour mining rather than MTRVF. The primary vegetation was similar to that of young reclaimed mines, except older reclaimed areas often harbored more black locust, as well as goldenrod species, blackberry/raspberry, multiflora rose, red maple, American sycamore, tuliptree, and sumac. The major distinguishing feature between young and older reclaimed areas was the presence of stands of pole-size trees in the latter habitat. Mine ages were estimated from the time of reclamation and age analysis of conifers throughout the study areas. Age data of reclaimed sites were obtained from Arch Coal and Cannelton Mining companies and from examination of permits.

Edge plots (point count stations and line transects) were selected based on vegetation type, i.e., where significantly large, relatively homogenous treatment habitats bordered each other. Edge plots were selected systematically to obtain at least 30 points per treatment and to survey all three of the mine sites and not just a few specific areas. Sampling plots were selected after P. Wood selected her interior plots and were placed at least 250 m away from her interior plots. This insured independence in data collection as well as avoided counting birds twice. In addition, plots were selected as randomly as possible by using a computerized random-number generator, taking into account the position of P. Wood s points, number of previously established edge plots in treatment habitats, and availability of suitable habitat on each mine site. To select plots, we GPS coordinates for used and available sites into a computer random-number generator and used the program to randomly select points. Edge points were also selected randomly within each mine site, and where chosen by habitat availability and size of watersheds and by the need to avoid proximity to interior plots.

Both ravine and ridgetop forest ecotones were studied. Grassland and forest fragment plots were located in the mines at ecotones, while intact forest treatment plots started at an ecotone on the periphery of the mines and extended into relatively large forest tracts. The lack of aerial photographs precluded precise confirmation of intact plots and the relative term intact was judged based on what we could see on the ground, from ridgetops, and from surveying the mines and adjacent landscape by car and examining topographic and mining maps. However, in March 2001 we obtained and examined aerial photographs and concluded correct assignment of edge treatments. Reclaimed grassland points were often placed in both head-of-hollow fills and on ridgetops above the valley fills.

Point counts in the Cannelton mine extended mainly along Sixmile Hollow of Hughes Fork, Hughes Creek, Bullpush, and Lynch Creek and tributaries of Smithers Creek (Table 3 and Figure 1). The ecotones were mainly grassland/forest fragments or shrub/forest fragments. Cannelton is an older mine site than Daltex and Hobet 21 and mining activity reclamation dates back to the mid 1980s through about 1992. The Cannelton mine also has considerably more contour mine areas than MTRVF and a higher percentage of reclaimed land in pole/shrub secondary succession. Consequently, most points were placed in shrub or pole/forest fragment ecotones and grassland/shrub ecotones. Ecotones extending east from Smithers Creek served as edge plots at the ecotone of intact forest and reclaimed mine. Relatively intact forest located along Ash Fork and Neil Branch of Twentymile Creek were too far from the reclaimed mine to warrant establishment of edge plots. Line transects were placed in Bullpush, Sixmile Hollow, and Jim Hollow (Figure 2).

Hobet 21 point counts were located mainly along tributaries of Mud River and Little Coal River. The area consists of mostly fragmented forest islands interspersed among grassland. Apparently, first order-streams had valley fills and second-order streams were left intact. The Hobet 21 mine is the largest surface mine in West Virginia and mountaintop removal was started in 1983 (J. McDaniel, pers. comm.). Older contour mine areas were reclaimed in 1975-1978 with black locust and fescue (e.g. Bragg Fork). Adkins Fork was permitted in 1975 (contour) and 1992 (mountaintop). Significant valley fill occurred in 1985-1987, but a variety of reclaimed valley-fills from 1988-1997 are prevalent. Some reclaimed areas are a result of point removal, where the tops of the mountains were removed, e.g., Big Buck Creek. European black alder, dogwood, and hawthorn were planted during reclamation. Edge points were established along intact forest of Hewitt Creek, while a variety of grassland/forest fragment and shrub or pole/forest fragment plots were established in Little Horse Creek, Big Horse Creek, Stanley Fork, Gum Hollow, Black Hog Hollow, and White Beech Hollow (Table 3 and Figure 3). Figure 4 shows localities of transects used for avian migration counts. The major watershed, Mud River, comprises 1,635 ha. and significant contour mining was permitted in 1975 and 1978. Significant contour mining is adjacent to Hobet 21, e.g., Hewitt Creek (a contour mine area reclaimed in 1989).

The Daltex mine consisted of mainly grassland and contained relatively little shrub/pole habitat, while edges along intact forest were located along Bend Branch of Spruce Fork. Both Daltex and Cannelton mines have significant amounts of their shrub/pole habitat created by contour mining, while Hobet 21 had more land cover in MTRVF. Left Fork of Beech Creek was contour mined in 1968-1969 and 1976-1978. Pigeonroost Branch was permitted in 1972-1974 and contour mines cover 181 ha. Table 3 and Figure 5 show location of point counts, while Figure 6 shows localities of transects.

Line transect localities were selected based on availability of treatment habitats. Elevation of the 40 transects was not normally distributed (Levene statistic = 6.42, $p < 0.004$), and varied significantly (Kruskal-Wallis test, $\chi^2 = 10.02$, $p < 0.007$). Elevation of 12 transects at Cannelton averaged 409.6 m (range = 107 m), 15 transects at Daltex averaged 397.7 m (range = 199 m), while 13 transects at Hobet 21 averaged 349.2 m (range = 129 m).

Historical Study Sites and Areas Sampled Prior to the MTRVF EIS

In 1987, we started a long-term study of bird populations in the southern West Virginia coalfields (Canterbury 1990, Canterbury et al. 1993). We refer to these sites (prior to the MTRVF EIS data collection that started in 2000) as Historical Sites. As part of our contractual agreement, we offered the MTRVF EIS committee an analysis of these data for comparing mountaintop removal with contour mining. This was because most of the mined areas we examined, prior to the MTRVF EIS, were pre-law land use (before 1977) and a large number of the sites contained unreclaimed areas including highwalls with natural succession. However, a significant number of sites (mined areas) had reclaimed areas in which trees (mainly black locusts and conifer spp.) were planted. One of us (Tommy Stover) spent many years planting trees on mined areas, and so we know exactly when these trees were planted.

Most of the 80 mine sites that we have examined from 1987-2000 were contour mines and were dominated by shrub habitat and second-growth forest. Some of these sites, however, were partial mountaintop sites with minimal valley fill and overburden. Table 4 shows the historical sites studied. These sites are found in the Allegheny Plateau and mainly within southern West Virginia, extending south of northern Summersville (Nicholas County), west to Logan, east to the Greenbrier River and south to Mercer/McDowell counties. Counties thoroughly sampled included Kanawha, Nicholas, Boone, Logan, Mingo, McDowell, Wyoming, Raleigh, Fayette, Summers and Mercer. Sites sampled within Raleigh County and extending into Pax, Fayette County, West Virginia are noted in Figure 7.

Most sites studied were mined in the mid 1960s to the late 1970s, and mine ages were determined by interviewing miners and coal company personnel and examination of permits. Contour mines were generally older, smaller in size, and more heavily forested than MTRVFs. The shrub habitat on these historical sites was comprised mostly of black locust and red maple bordering mature and second-growth deciduous forests. Much of the land mined in the 1960s and 1970s is now second-growth forest (upland oak-hickory/Appalachian mixed-hardwood). Thus, natural forest succession and reforestation procedures (see Burger and Torbert 1997) have converted many of these 30-40 year old mines into second-growth forest. Remnants of pioneer (legumes and grasses) and shrub (black locust, autumn olive, and serecia) species remain in edges and forest patches in the contour mines. Edges along these historical sites were primarily transitional ecotones between shrub and extensive forest and forest-road edges. Relatively large grasslands (> 40 ha.) were rare on these mines (4% of the sites surveyed) and were more abundant in mountaintop rather than contour sites. Edges on historical MTRVFs were as described above, except there were some abrupt grassland-forest edges. In other words, edge sampling points at historical sites were selected as described for the three EIS MTRVF sites discussed above. Undisturbed sites bordering these mines were generally mature oak-maple-hickory forests. Dominate tree species included red maple, sugar maple, yellow poplar, red oak, hickory spp., sourwood, black birch, and black gum.

Outslope areas of reclaimed mine sites were dominated by black locust, red maple, sourwood, black birch, tulip tree, pitch pine and Virginia pine. Flat areas were dominated by pine spp., black locust and red maple. Highwalls and un-reclaimed areas were dominated by black locust. Reforestation occurred faster on outslope areas than flat tops. Reclamation practices (e.g., seed mix, whether trees were planted) were noted and used in analyses. Canterbury (1990) described the typical habitats of these mines, and some of these study sites are noted and described in Canterbury et al. (1993, 1996) and Canterbury and Stover (1999). Pitch, Virginia, and white pines were the most commonly found pines of these areas. Autumn olive, multiflora rose, goldenrod spp. and blackberry spp. predominate in the shrub and herb layers. Vegetation in these 80 mine sites is similar in composition and structure to the MTRVFs noted above, except contour mines are steeper (Sparks and Canterbury 1999, Watson and Canterbury 1999, Canterbury, unpubl. data).

Historical mine sites were classified by methods of mining activity, which included (1) contour/auger, (2) partial mountaintop with outslope and minimal valley fill (PMTRVF), (3) mountaintop removal and valley fill (MTRVF), and (4) mixed (combination of methods employed in about equal proportion). Data for classifying sites were obtained by examination of permits, interviewing miners and mine and forestry experts, and extensive field experience.

The following two paragraphs are descriptions of some of the historical mine sites studied. An extensive amount of mining has occurred in the area between Valley and Clear Fork districts of Fayette and Raleigh counties with discharge into tributaries and streams feeding Paint Creek and Clear Fork (Table 4). Much of the mined areas near Pax, West Virginia are contour mines. A study plot (29 ha.) was placed in the Plateau district of Fayette County that was permitted in 1985 and completely revegetated by 1989. Disturbance impacted Bee Branch, Georges Branch, Long Branch and Shotgun Hollow of Paint Creek of Kanawha River. The Coopertown mine in Boone County was a MTRVF and auger operation with approximate original contour (AOC) variance (Office of Surface Mining, OSM). The permit called for creating a level plateau along the ridgetop. A mountaintop-removal AOC variance, leaving a level plateau or gently rolling contour, is granted if it is capable of supporting certain postmining land uses (OSM). A permit was issued for this site in 1976 and about 39 ha. were disturbed. Valley fills are now well vegetated with trees (OSM). The ridgetop between two valley fills along the eastern AOC is forested, and disturbed areas are mainly in the shrub stage of secondary forest. A MTRVF site northwest of Gilbert disturbed about 35 ha. and had three valley-fills, while the mined areas were back-filled to within 12 m of the original contour (OSM).

The Sandlick/Stover area of Raleigh County have operations discharging into Harpers Branch and Sandlick Creek of Marsh Fork of Coal River (Table 4). The mining methods appear mixed with mountaintop-removal AOC variance and the initial application listed the operation as steep-slope mining and returning the land to AOC, but we found little evidence of the latter. We sampled several mine sites along Sandlick Creek that were permitted in 1978 and where no coal has been removed since 1993. One study plot was placed on an area permitted for 190 ha., where 11.3 % of the land has not been disturbed. All mined area have been completely revegetated and the area harbors dense locust stands with a breeding population of imperiled Golden-winged Warblers (Canterbury et al. 1993). Over the past several decades the Golden-winged Warbler has been gradually replaced by Blue-winged Warblers, and hybrids between the two species have been documented (Canterbury et al. 1996). However, the potential loss of elevation due to mining did not favor Blue-winged Warblers over Golden-winged Warblers, since both species readily coexist throughout the Marsh Fork and Sandlick watersheds where the habitat is heavily forested with some relatively old contour mines (mined in the 1960-1970s). The area to the west of Sandlick, namely Guyandotte (Bolt) Mountain harbors the highest known breeding population of Golden-winged Warblers (Canterbury et al. 1996; Buehler et al. 2002, Canterbury, submitted; (http://www.audubon.org/bird/iba/iba_map.html). Areas such as Peachtree Ridge, Pilot Knob and Coal River Mountain harbor large source populations of Golden-winged Warblers along contour mines, but Blue-winged are encroaching into these higher elevations (Canterbury et al. 1993, 1996). Despite encroachment of advancing Blue-winged Warblers, Golden-winged Warblers have remained relatively common throughout the southern West Virginia coalfields, which is true for both contour and MTRVFs (Canterbury and Stover 1999, Buehler et al. 2002).

Avian Species-richness and Abundance

Avian abundance was quantified by fixed-radius 50-m point count plots during the winter and breeding seasons and line transects during the migration periods (Ralph et al. 1993). All point counts and line transects were geographically referenced with a global positioning system (GPS) and downloaded into Garmin MapSource 3.02. The point count method is a standard, published technique for quantifying avian abundance along edge and other habitats and provides an index of relative abundance of species encountered. All point count stations were located along abutting habitat types within a 50-m radius and were placed at least 75 m from major strip mine roads. Counts were conducted using standardized methods of Ralph et al. (1993), such as 10 min. counts per point and conducting counts from 0630 to 1030 hrs. during the breeding season. Winter point counts were conducted from 0730 to 1600 hr because birds can forage at any time throughout the day during the winter months. We visited each edge point count twice during both the winter (January - mid April) and breeding (June - mid July) season. Plots were visited randomly between counts and not in the same order both times (Ralph et al. 1993). Surveys were not conducted during heavy snow fall or during windy or rainy weather. Percent cloud cover and wind speed (obtained with a wind meter) were recorded using standard scoring codes (Ralph et al. 1993). Seven observers with experience ranging from 2-14 years conducted point counts. Birds were counted at 134 edge plots during the winter and breeding seasons and were also counted at 80 interior treatment plots of P. Wood during the winter months. We recorded the number of birds per species seen or heard, as well as noted breeding pairs, number of flyovers, and whether each bird was observed within or outside the 50-m plot (aided by Bushnell range finder).

Three observers (each with 5 to 14 years experience) conducted migration counts. At 40 random sampling points per treatment habitat, we established 300-meter line transects throughout the three mine sites. Of the 40 line transects, we had 10 each in treatment habitat chosen by P. Wood during a pilot study. These included grassland, pole or shrub succession, forest fragment and forest plots. Transects were fixed width of 50 meters and started at edges and extended 300 meters into the appropriate treatment habitat. Migrants were counted from 0630 - 1200 hr. and counting times varied slightly between spring and fall migration periods, but were generally within 15 minutes of local sunrise and spanned three to four hours after sunrise. Birds were counted by walking the transects at a rate of 100m/10 minutes. Each transect was visited twice during the spring (April 11 - May 31, 2000) and fall migration (August 1 - September 10, 2000). We did not sample during the latter part of fall migration (i.e., no data collection in late September and October), because of the cut-off for ending the EIS. All birds were counted, including resident species, short-distance migrants, and Neotropical or long-distance migrants. Migrants are reported as number of birds observed per count in each habitat type along 300-meter transects extending from edges to interior plots.

Relative and total abundances were computed as the number of birds per point and birds/ha. Diversity of birds was calculated for each edge type with the Shannon-Weiner formula. When ecologists study an ecosystem they want to know what are the most important species and why are they important? So that different ecosystems or communities can be compared, standard measures of importance have been agreed on and studied. A species may be important because of its relative abundance, size, and dispersal, e.g., relative density measures the abundance of a species, relative to the abundances of the other species present. Once we have calculated a species' relative abundance, size, and dispersion, we use this as a measure of its total importance in the community. Importance Value (IV) can sum to 200 or 300 depending upon whether two or all three of these parameters are used. IV is used mainly to quantify vegetational communities, but plants and habitat structure often dictate occurrence of animals. We computed an importance value for each species in winter and summer as a means of comparing the presence of a given species to the total bird community (Yahner 1986, 1993, Rollfinke and Yahner 1990). An IV was the sum of a relative numerical component (RN) and a relative distribution component (RD), giving a maximum possible of 200 (Yahner 1986). The RN was the total number of detections of a given species with points pooled divided by the abundance recorded for the most abundant species. This is a way of comparing the abundance of a species relative to the most abundant species detected. The RD was computed as the proportion of the four edge type plots in which a given species was detected (Gutzwiller 1993). We classified high IV as 125, moderate as 50-124, and low as 49 (Yahner 1986, 1993, Rollfinke and Yahner 1990).

Birds were assigned to foraging height (low or high) and habitat guild (e.g., forest-interior, shrub, and edge, based on habitat preference). Birds were assigned to guilds and residency and migratory status based on the literature (see Hall 1983, Ehrlich et al. 1988, Buckelew and Hall 1994) and our 14 years of research experience with birds of West Virginia. For example, we assigned Downy Woodpecker and White-breasted Nuthatch to the trunk gleaner (bark forager) guild. Root (1967) and Yahner (1993) provide excellent examples of assigning avian species guilds. Typically three principal foraging guilds were used and noted as ground-shrub foragers (species that often feed on or < 2 m above the ground level), trunk-bark foragers (species that forage on tree trunks or large branches), and sallier-canopy foragers (species that often forage > 2 m above ground level in vegetation).

Edge type was used as the independent variable in analysis of variance (ANOVA), and we tested for differences in species richness, relative abundance, and foraging guilds (e.g., ground/shrub, bark, canopy) across habitat (treatment) types. Additional analyses are described in the Statistical Analyses section. Bird species that are typically difficult to survey with point counts, such as flocking and highly gregarious species, inconspicuous and non-vocal species, and species with large territories or home range, were excluded from the analyses of abundance, species richness, and guild structure. Avian nomenclature follows the American Ornithologists Union checklist of North American Birds (AOU 2000, see Appendix 2).

Topology and Spatial Variation

Because MTRVF produces forest fragments (patches) and edges of varying length and width, we assessed edge variation at each point by quantifying the length of each edge, aspect, elevation, and percent slope with GIS (see below). The area or size of a patch (e.g., in units of a map scale such as m^2 or a proportion of the total map/study area) may be subdivided into edge and interior (core) area, where edges are defined in terms of some buffering distance. Virtually all GIS package can quantify the area or perimeter (edge) of patches (e.g., polygons). We took GPS coordinates where habitats changed and plotted these coordinates on a topo map. We overlaid the topo maps with a grid of 999 boxes (2.5 acres each) that are typically used with 7.5-minute USGS topographic maps or aerial photographs with a scale of 1:24,000 (1 in. = 2,000 ft.) and determined the approximate length and width of edges. The total length of each edge was verified using a spatial analysis program (APACK, Boeder et al. 1995). Elevation was obtained from topological maps by plotting localities of points on maps, while aspect was recorded with a compass. Percent slope was obtained from a clinometer. Slope aspect was transformed using Beer s (1966) equation, where A = (COS(45-A)+1) x 2 + 1. In this equation A is the transformation index and A is the direction the slope faces in degrees (Frazer 1992). Slope transformations range from 5 (northeastern facing, mesic condition) to 1 (southwestern, xeric condition). We assigned an aspect index of 1 to dry, xeric ridgetop points and 5 to points in mesic valley floors, since they have no slope and aspect (Frazer 1992).

We quantified patch size of forest fragments and habitat variation among sites and treatments with FragsStats computer software, GIS, ANOVA, and product-moment correlation (see Statistical Analyses). GPS coordinates of all edge points were transferred to GIS (ARC/VIEW 3.2 or ARC/INFO software 3.4D GIS, ESRI 1987) and data from the WVDEP spatial data interface was used to develop GIS maps, which were created by delineating habitat patches along the points and transects. ArcView extensions spatial analyst, 3D analyst, TIFF 6.0 image support, geoprocessing, and MrSID image support were used in GIS analysis. We compared the number of birds (density estimates and species richness) in various edge habitats (treatments) and watersheds by topology (edge length and width, elevation, and slope) and vegetation (described below) using multiple regression. In other words, we used multiple regression analysis to examine which of these variables (slope, edge length, plant richness) were significant predictors of avian species abundance.

Vegetation Analysis

Vegetation analysis was used to quantify edge types among the watersheds and treatment habitats. Vegetation characteristics at each edge point were quantified in July - early September at the end of the growing season and after avian count surveys were completed. We used a modification of the James and Shugart (1970) circular sample-plot method to sample the vegetation within edge point counts. We placed four circular plots of 0.032 ha (20 m diameter or 10 m on either side of the edge) within the bird sampling plots and recorded (1) height and species of all trees 3 cm diameter at breast height (DBH), (2) the number of all woody stems < 3 cm DBH and 0.5 m tall within two perpendicular, 2 m wide x 20 m long transects, (3) a count of all vine stems or vine leaves that intersected the centerline of the two perpendicular transects, and (4) an estimation of vertical structural diversity by noting the presence or absence of vegetation at height intervals of 0-0.3 m, 0.31 - 4 m, 4.1 - 10 m, and > 10 m as observed with a sighting tube. Ground cover type was recorded as either green herbaceous (grasses, shrubs, ferns), bareground/rock, moss, woody debris (any material 4 cm diameter), water, or leaf litter. Percent ground cover and canopy cover was estimated using a 4 cm diameter ocular siting tube (James and Shugart 1970). Average canopy height was measured with a clinometer. Canopy cover and structural diversity was measured in shrub/pole and forest plots. Plants were identified using standard field guides and Strausbaugh and Core (1977). Diversity of shrubs and trees were calculated with the Shannon-Weiner formula (Magurran 1988), but we found plant species richness not to be a significant predictor of avian richness and abundances along edges.

Along grassland edges, a meter stick was randomly placed on the ground within each point count circle and a 6 mm diameter metal rod was passed vertically through the vegetation at each end of the meter stick and the number of contacts by different vegetative life forms (e.g., standing dead vegetation, grasses and sedges, forbs, shrubs 15 cm and shrubs 15 cm high) were counted in each successive 1 decimeter (dm) height interval (Rotenberry and Wiens 1980). Litter depth was measured from the surface of the ground to the top of the litter with a metric ruler.

We also performed a separate analysis of shrubland ecotones (abbreviates for variables measured are indicated in parentheses), in which we counted trees with DBH > 7 cm (TREE), shrub stems 3-5 m in height and 7 cm DBH (TALL), shrub stems 1-3 m tall and 7 cm DBH (SHORT), and standing dead trees greater than 7 cm DBH (DEAD). We estimated height (HEIGHT) of overstory trees with a clinometer and measured their DBH.

Statistical Analyses

Data were analyzed following Sokal and Rohlf (1981). We tested our data for normality (e.g., species richness and abundances) and for most of our datasets we found no evidence of deviation from normality (Levene statistic or Shapiro-Wilks test, $p > 0.05$). Non-normal data were transformed for parametric analysis. All percentage variables (i.e., slope, ground cover, and canopy cover) were arcsine-square root transformed (Sokal and Rohlf 1981). Pearson product-moment correlation was used to examine the relationship among all variables in this study, e.g., seral stage (age of succession) or treatment, edge length, edge type, elevation, percent slope, aspect, species richness, and relative abundance. Pearson product-moment correlation analysis was also used to examine the relationship among species diversity and vegetation components measured at shrub or pole/forest fragment edge study plots in MTRVFs. Significant correlations were further analyzed with general factorial ANOVA. Day of data collection in count studies was used as a covariate within analysis of covariance (ANCOVA) models, but was found not to be a significant covariate in each seasonal analysis. Habitat association data were analyzed with Principle Component Analysis (PCA). All data were analyzed with SPSS for Windows (Norusis 1993) and are reported as mean ( ) ± 1 standard error (SE). Graphs were constructed using SigmaPlot 5.0 and study plots were plotted with Garmin 3.02 topomap software.

Quality Control Procedures

Four treatment designs (habitats) selected by P. Wood and edge plots similar to these treatments were replicated at each site, but an unbalanced sampling design among edge plots was necessary because of the lack of specific treatment habitats in some areas and to avoid overlap with point counts in interior plots. Confounding variation was reduced by sampling with multiple replicates across edge types, which provided adequate statistical inferences about avian abundance and diversity among habitats or treatments. The selected edge points were representative of the edge habitats on the three mines and were selected to maintain sampling efficiency per unit time.

Quality control was also maintained by using 2-7 person teams from the SWVBRC and Concord College that minimally have two years of point count and avian research experience. Student assistants with two years experience were teamed with more experienced researchers and conducted trial point counts prior to initiating surveys. These included at least three practice sessions in each habitat type (grass, shrub, and forest) at the beginning of the winter and breeding seasons. These researchers also practiced completing standardized point count data sheets and placing birds within or outside 50-m radius circles with distance sampling verification (i.e., measuring off 50 meters). The Chief Naturalist of SWVBRC, Dollie Stover, has over 14 years of avian research experience and is highly respected as a birder by the West Virginia birding community. Allen Waldron of the SWVBRC has over 20 years of experience with forestry and botanical techniques, and five years of avian research experience. The PI was in the field 475 hours, comprising 60 field days, which insured quality control of data collection and that data collection adhered to standardized protocols (e.g, Hutto et al. 1986).

Quality control for winter point count data was insured, for example, by adhering to standard protocols, where data were collected only when wind speed was < 20 km/h, air temperature was > 0°C with no more than a light precipitation, and the ground was relatively snow-free (i.e, ground not completed covered with snow). The estimation of sampling error in bird surveys often involves replication in space or time (Gates 1981). The large sample sizes, i.e., number of point counts per treatment and edge type, improved the statistical power. Rarefaction was employed in this study. Rarefaction is a statistical technique for estimating the number of species expected in a random sample of individuals from a collection, and allows the comparison of the species richness of collections with varying numbers of individuals (James and Rathbun 1982). Data entry from field data sheets was checked by a second technician after entry for any potential errors. In summary, the standard sampling methods, experience of researchers identifying birds by sight and sound, and sound statistical approaches (e.g., habitat data analysis with PCA) used in this study insured quality control.

Methods used to Collect and Analyze Data from Historical Sites

Vegetation sampling followed procedures outlined above for MTRVFs, except that slight modifications were made in some shrubland plots for specific studies on the imperiled Golden-winged Warbler (see Canterbury et al. 1996, Sparks and Canterbury 1999, and Watson and Canterbury 1999). Other modifications in sampling design is shrub habitats included spot mapping and an intensive multiyear investigation of breeding populations of color-banded birds using netting, playback, and observation. These latter data are reported elsewhere (e.g., Canterbury et al. 1996), but are occasionally referred to in this report.

Point count methods on historical sites followed methods described above for the surveys on the MTRVFs. Point count data were collected in June at each site. All interior points were at least 250 m from the nearest edge. We placed at least 12 interior and 12 edge plots at each site with some sites (e.g., Peachtree Ridge) having 32 of each. Thus at each mine site, we conducted at least 24 point counts per year. Point count data were compared between edge and interior plots and we calculated avian relative abundances from these point count data as described in the methods for the MTRVF EIS study sites. Point counts were placed along contour mines and valley-fills of mountaintop sites.

In addition to point counts, singing male censuses (SMC) modified from the methods of the BBS and outlined in Hall (1983) and Canterbury et al. (1996) were taken at 32 sites. These SMCs started at the historical mine site and extended along roads and forested areas and were denoted as routes for estimating population trends. The SMC routes were not the same as point count stations. During the past 14 years, SWVBRC staff have conducted a multitude of BBS and SMC censuses on 80 mine sites, which consisted of relatively remote roads through extensively forested areas with contour mine edges (Stover and Canterbury 2001). These historical study sites averaged 79% forest cover and 21% shrub edge and other habitats (Canterbury, unpubl. GIS data). Researchers from the SWVBRC collected SMC and BBS data in June and followed the standardized BBS protocol. Many different methods have been used to analyze BBS and SMC data and there is little agreement on which are best (Thomas and Martin 1996). We used trend estimation (an exponential curve was fitted to the mean number of birds recorded per route in each year) and regression methods of Geissler and Sauer (1990) and Link and Sauer (1994). Due to the volume of this report, we have omitted graphs of population trends of southern West Virginia birds, but these can be obtained from the senior author.

Species recorded on fewer than 14 routes were omitted from trend analysis (Peterjohn et al. 1996). Migratory status was assigned to each species based on the most common wintering grounds of each species (Rappole et al. 1983). Permanent residents were delineated as those species in which most individuals breeding in West Virginia also winter in the state. Temperate migrants were considered species that winter mainly in the southern U.S. and have large migratory flights through the area (see Canterbury and Stover 1998, Canterbury et al. 1999, Canterbury 2000b). Central Neotropical migrants winter in Mexico, Central America, and the Caribbean, and southern Neotropical migrants winter mainly in South America. Considerable variation exists among species and some have large winter ranges encompassing southern U.S. to Panama, but we labeled each bird species by where the bulk of their winter populations occurs. For example, Central and southern Neotropical migrants were defined as those that winter primarily south of the U.S., and temperate migrants included those that winter extensively in North America but have some populations that winter south of the U.S. (Gauthreaux 1991). Similarly, some resident species such as the Song Sparrow have large winter populations consisting of short-distance migrants from farther north and are classified as both permanent residents and temperate migrants. For association with breeding population trends, each species abundance (per SMC route) was classified as either very abundant (VA, 50.0), abundant (A, 12.0-49.9), common (C, 4.0 - 11.9), fairly common (FC, 2.0 - 3.9), uncommon (U, 1.0 - 1.9), or rare (R, < 1.0) and these classifications correspond to regional abundances (Peterjohn et al. 1987). Routes were the typical 24.5 mile routes with 50 stops and observers recorded numbers of individuals of each species seen or heard within a 0.25 mile radius during a 3-min. period. Routes consisted mostly of forested areas with remote roads created mainly by contour mining. Population trends were estimated from data from these routes.

At TRMO (Metalton, Raleigh County), we placed 12 300-meter transects for counting birds and compared count data with mist-netting data. Procedures for counting birds along these transects followed standard methods (Ralph et al. 1993). We randomly picked three interior forest species (Ovenbird, Acadian Flycatcher, and Kentucky Warbler) and three shrub/edge species (Eastern Towhee, Northern Cardinal, and Indigo Bunting) and plotted the number of birds/40 ha. from edge to interior forest. Banding methods used at TRMO followed those described in Karr 1981, Moore et al. (1990), Morris et al. (1994), Pyle (1997), and Canterbury and Stover (1998). These methods allowed comparison between edge and interior areas.

The TRMO study site is described in Canterbury (1990), but has been modified slightly in recent years by selective logging and contour mining. The contour mine habitat characteristics are similar to the MTRVFs, except the contour mine at TRMO is smaller than the MTRVFs described above. We use bird banding data to illustrate what migrants potentially use mine habitats and show data collected from 1996-2000, where fall migrants were captured from late July to early November (see Canterbury and Stover 1998, Canterbury et al. 1999, Canterbury 2000b). This is important, since the MTRVF EIS data collected excluded October and much of September, which are suitable for bird migrations in southern West Virginia (Canterbury et al. 1999).

Vegetation quantification at 19 (12 contour and seven MTRVF) randomly selected historical mine sites followed the James and Shugart (1970) circular sample-plot method and GIS technology was performed for only three of these historical sites because of time constraints. These three historical sites (Peachtree Ridge, Highland Mountain, and Whitby) were selected because they are localities where the long-term data collection began and are areas where we have the most data, including avian reproductive success data (see Canterbury and Stover 1999 and Stover and Canterbury 2001). Statistical analyses of historical data follow procedures outlined above and those described in Canterbury et al. (1996). Association among variables were examined with Pearson product-moment correlations. Analysis of variance (ANOVA) and multiple regression analyses were the main types of tests employed. These latter tests were used to partition variation among measured variables and to test for significance in dependent variables (e.g., avian abundance, species richness) as explained by independent variables (e.g., mine size, mine age, type of mining in study plots, slope, elevation, canopy cover, herbaceous cover, tree density, tree size (height), stem density, and age of forest succession). A multiple regression was used to determine which habitat variables were significant predictors of five randomly chosen shrubland species. Nonparametric tests were used on non-normal datasets (see Sparks and Canterbury 1999, Watson and Canterbury 1999). For example, we used the Mann-Whitney U-test to examine difference in abundance between edge and interior plots at TRMO.

Results and Discussion

Avian Abundances across Seasons and Edge Habitat (Treatment) Types

Winter Season

Table 5 shows the average number of birds observed per point count in the winter season. This table also shows a comparison between interior and edge plots. Of the 59 species listed in Table 5, only seven species were more abundant in interior as opposed to edge plots. These are Blue Jay, Carolina Chickadee, Pileated Woodpecker, Sharp-shinned Hawk, Tufted Titmouse, White-breasted Nuthatch, and Yellow-bellied Sapsucker. Seven species were found in higher densities at forest fragment/grassland ecotones than in intact (large) forest/ grassland ecotone, forest fragment/shrub ecotone, and shrub/grassland ecotone (data not shown, but summarized as one-way ANOVA, F 2.95, p 0.05). These included the Eastern Meadowlark, European Starling, Horned Lark, Killdeer, Northern Harrier, and the Wood Duck. The remaining species did not vary by edge type during the winter (one-way ANOVA, $p > 0.05$). Overall, the American Crow and Dark-eyed Junco were the most abundant species observed during the winter, which is consistent with most Christmas bird counts in the regions (Canterbury 1998). These species also had the highest importancr values (Table 6). However, the high abundance of Eastern Bluebirds, Eastern Meadowlarks, and Horned Larks in MTRVF grasslands and shrub habitats are especially noteworthy in comparison to regional Christmas bird counts. During winter point counts, foraging-flocks of American Robins, Eastern Bluebirds, European Starlings, Horned Larks, Northern (Yellow-shafted) Flickers, or Wild Turkeys were noted almost daily in grasslands and shrub habitats. In addition, some species were higher in the winter than summer season. These included, for example, American Crow, Blue Jay, and Pileated Woodpecker. Reasons for these seasonal abundance differences vary. The American Crow congregates in large foraging and communal roosting areas (Canterbury and Stover 1992), while the Pileated Woodpecker may be more easily detected in winter than summer. Many overwintering Blue Jays, Dark-eyed Juncos, and Song Sparrows breed farther north and represent short-distance migration.

Spring Migration

The number of birds observed per transect during the spring migration period is shown in Table 7. Of the 29 species noted in predominantly grasslands, the European Starling, Turkey Vulture, Eastern Meadowlark, and Tree Sparrow were noted in highest numbers (from highest to lowest), respectively. Of the 63 species that were found in mainly shrub habitats, the Field Sparrow was the most abundant, followed by the White-throated Sparrow, American Robin, Blue-winged Warbler, and Chipping Sparrow (excluding the Wild Turkey since it does not migrate). Of the 40 species that predominated in forests, the Red-eyed Vireo and Wood Thrush were the most abundant migrants (excluding American Crow, which overwinters in the area). Table 8 shows the mean species richness and total abundance of birds detected along treatment habitats in spring. Fewer species were detected in intact forest, while shrub habitats harbored the greatest species richness. Similar trends were noted for density and total abundance estimates. We compared species richness and avian abundance along variable distances of the transect (0, 150, and 300 m) and found no differences (Table 9).

Breeding Season

Table 10 shows the average number of birds observed per point count in the breeding season. In general, the overall trend was higher abundance in shrub/forest fragment ecotones for forest interior species, interior-edge species, and edge species. Grassland species were significantly higher at grassland/forest fragment ecotones. Forest interior species generally declined in grassland/forest fragment plots as opposed to grassland/intact forest edge. Table 9 also shows a comparison of avian abundances between this study and southern West Virginia (at smaller contour mines in relatively late stages of secondary succession - see Canterbury et al. 1996, Canterbury and Stover 1999, and historical sites described above). For this comparison, we randomly picked sites in southern West Virginia with relatively similar habitat (vegetation and topography) and approximate age as the MTRVF sites. We selected 30 points in each edge habitat type in southern West Virginia from a pool of hundreds of counts distributed over 80 sites (Canterbury, unpubl. data). In general, the contour/partial mountaintop sites selected for this comparison were slightly older and smaller than the MTRVFs used in this study. However, a significant amount of similar edge habitat created by contour mining occurs on both the MTRFV sites and older contour mines in southern West Virginia.

Abundance of each forest interior species, except Louisiana Waterthush and Swainson s Warbler (no birds observed) and Yellow-throated Warbler, was slightly lower at the grassland/intact forest edges of the MTRVFs of this study than at similar habitats throughout southern West Virginia. This difference may be due to the slightly younger ages of the MTRVF grasslands as compared to the contour mines, but was not tested for significance (we chose not to test across studies - historical contour mine data and present MTRVF). A similar trend was noted for grassland/forest fragments, except for Cerulean Warbler (no birds observed, see Table 10), Eastern Wood-Pewee, Kentucky Warbler, Louisiana Waterthrush (no birds observed), Summer Tanager, and Yellow-throated Warbler. The latter two species were more abundant on MTRVFs than older contours, and are typically found in open woodlands. In general, similar trends were also noted during comparisons of the other two edge types, where birds were in slightly higher densities in older contours than at MTRVF shrub edges. These comparisons, however, should be interpreted with caution, because abundance estimates of birds on contour mines throughout southern West Virginia are based on 14-years of data and the MTRVF EIS study was only for one year. Likewise, each forest interior species should be examined carefully. For example, the Acadian Flycatcher was found in about equal numbers across all edge types in the MTRVFs, except grassland/shrub. It did not, for example, decline in comparison with the larger, relatively intact forest edge bordering the MTRVF mine sites. In the MTRVF sites of this study, forest-interior species were often found in the same relative densities in both grassland/intact forest edge and grassland/forest fragment edge, but exceptions did occur (e.g., Blue-headed Vireo, Cerulean Warbler, Eastern Wood-Pewee).

The species with the highest IV (ranked in descending order) during the summer (breeding season) were Red-eyed Vireo, Indigo Bunting, Grasshopper Sparrow, Field Sparrow, Common

Yellowthroat and Eastern Meadowlark (Table 11). Two of these are considered grassland species (Grasshopper Sparrow and Eastern Meadowlark), three are edge/shrub birds (Indigo Bunting, Field Sparrow, and Common Yellowthroat), while the species with the highest OV, the Red-eyed Vireo, is considered an interior-edge species of the eastern deciduous forest. Species richness varied from 10.02 (± 0.31 SE) in grassland/shrub, 12.05 (± 0.40) in grassland/intact forest, and 12.61 (± 0.37) in grassland/forest fragment to 15.56 (± 0.32) in shrub/forest fragment.

Table 10 shows a group of species listed in an Other category and not in a particular habitat. These are generally birds of large open habitats or aerial insectivores. The species in the Other category were generally more abundant in grassland/shrub edges. The Canada Goose, Green Heron, Black-billed Cuckoo, Eastern Kingbird, Eastern Wild Turkey, Rock Dove (Feral Pigeon), Chestnut-sided Warbler, Common Raven, House Wren, Rose-breasted Grosbeak, and Wood Duck were also observed during the breeding season, but were outside of standard point counts and not used in calculating abundance estimates. Reasons for this vary. For example, some are more abundant at higher elevations outside EIS study sites (e.g., Chestnut-sided Warbler and Rose-breasted Grosbeak), some require specialized or localized habitats such as open oak-hickory woodlands and localized areas with tent caterpillar or other lepidopteran outbreaks (e.g., Black-billed Cuckoo), and some occur in the vicinity of human dwellings (e.g., House Wren and Rock Dove).

Fall Migration

The most abundant birds observed in grasslands during the fall were Turkey Vulture, Mourning Dove, and Grasshopper Sparrow (Table 7). However, these probably represent post-breeding dispersal rather than migration, because data were collected too early for their migration cycles (Hall 1983). In grasslands, no long-distance migrant that does not breed in the area or in close vicinity of the MTRVFs was noted. This was probably due to a time limitation rather than habitat, since we observed migrants only from August to mid September. Optimal dates for many fall migrants in southern West Virginia span into late October (Canterbury and Stover 1998, Canterbury et al. 1999, Canterbury 2000b). In shrub habitat, the White-eyed Vireo was the most abundant, followed by the Tennessee Warbler and Gray Catbird. In forest habitat, the Carolina Chickadee was the most abundant species in fall season, the population in winter is generally higher than the breeding population (Hall 1983). This may represent an influx from the north. The Red-eyed Vireo was the most abundant long-distance migrant, but like the White-eyed Vireo and Gray Catbird in shrub habitat, it is often difficult to distinguish migrant from breeding individuals without banding. The Cape May Warbler and Swainson s Thrush may be better indicators of forest migrants along MTRVF, since they do not breed in the area (Table 7). Bird banding, rather than migration counts, is generally a more precise method for evaluating indicator species during migration. Table 12 shows the number of birds banded at TRMO during the past five seasons and the percentage of the total migrants captured on a contour mine in Raleigh County, West Virginia. Clearly, shrub habitats are valuable for migration for many avian species and migrants are not limited to mature forest tracts. However, shrub habitats may be important for migration only in the context of the surrounding landscape (i.e., contiguous forest).

Guild Analyses

The number of birds per guild type did not differ across edge habitats (Table 13, MANOVA, F 1.36, p 0.29), but did vary with season (F = 4.48, p 0.03). As expected, more birds were noted in summer than during the winter season. There was a significant difference in the number of low and high foraging birds across age of secondary succession (Figure 8, ^{2} = 7.41, p < 0.02). Table 14 shows linear regression analysis of species richness and relative abundance on length of edges along MTVFVs in southwestern West Virginia. Species richness within the five major trophic groups was significantly correlated with edge length. Areas with large amounts of edge and forested island patches contained significantly more omnivores, ground insectivores, and aerial insectivores (mainly flycatchers) and had fewer foliage and bark insectivores. The rate of increase (slope) of ground and aerial insectivore richness with edge length was high and indicates the importance of increasing amount of edge habitat to these species. This was further demonstrated by intercepts that did not differ from zero, which suggest that large tracts of forests are not preferred by these groups. In contrast, foliage and bark insectivores had higher intercepts, which indicate their preference for larger forest tracts and less edge. In addition, the negative slope of relative abundance of bark insectivores suggests that they prefer large tracts of forest and that abundance decreases with decreasing richness. Foliage insectivores, however, did not follow the same pattern as bark insectivores with regard to relative abundance, i.e., abundance increased with decreasing species richness. Omnivores and aerial insectivores increased abundance in fragmented landscapes (patches) according to their slopes in Table 14, while relative abundance declined in ground insectivores as species diversity increased in fragmented, high edge areas.

Habitat and Topology at Sampling Points

The percent slope of grassland/forest ecotones averaged 23.8 ± 2.61 (SE) and did not vary between intact and fragmented forests (t = 0.12, p > 0.92). Slopes were not as steep along shrub ecotones and averaged 17.51%. Aspect code varied from 2.10 ± 0.30 in grassland/ forest ecotones to 1.95 ± 0.20 in shrub/forest ecotones. There was no difference between intact and fragmented forest aspects (t = 0.19, p > 0.65). Percent green ground cover varied along edge types and was highest in the grassland/forest fragment ecotone, where it averaged 69.23 ± 1.88 %. The percent litter cover (grand = 29.61 ± 1.40 % among the four edge types) did not vary much, since most plots were placed along forested ecotones that receive leaf-fall-off during the fall season, but was lower in shrub/grassland ecotones (= 12.73 ± 1.28%). Stem densities (no/ha of those < 3.0 cm DBH) of trees were lowest in grassland/intact forest ecotone (= 3,102.61) and highest along pole/forest fragment ecotones (= 5,200.11). Percent canopy cover varied from 37.69% along shrub/forest fragment ecotones to 9.81% along grassland/ shrub ecotones. The amount of woody debris was highest in shrub/intact forest ecotones (= 2.95 ± 0.32%) and lowest in grassland/shrub ecotones 0.75 ± 0.01%). Vine stem counts varied from 1.6% in grassland/shrub ecotones to 4.9% in shrub/intact forest ecotones.

The number of different vegetative life forms (i.e., standing dead vegetation, grasses and sedges, forbs, shrubs 15 cm and shrubs 15 cm high) were counted in plots along the four ecotone types and varied as expected. For example, there were significantly more grasses, sedges, forbs, and shrubs less than 15 cm high in grassland/forest ecotones, where *Sericea* *lespedeza* made up 20.4% of the vegetation. The highest number of shrubs > 15 cm high was noted in shrub/forest fragment ecotones, where it averaged 31.4%. As expected tree height increased with age of succession, but we found no significant difference in tree height between fragmented and intact forests ($t = 0.175$, $p > 0.85$). Plant species diversity did not differ significantly across edge types (one-way ANOVA, $F = 0.38$, $p > 40$), but was slightly higher in shrub/forest fragment ecotones. The species of plants identified on MTRVFs in this studies are listed in Appendix 1.

Pearson product-moment correlations among topology variables (percent slope, aspect, elevation, age of secondary succession, and edge length) and species richness are shown in Table 15. Avian species richness was significantly related only to edge length. Table 16 shows correlations among species richness and number of trees with DBH > 7 cm (live tree), shrub stems 3-5 m in height and 7 cm DBH (tall shrub), shrub stems 1-3 m tall and 7 cm DBH (short shrub), and standing dead trees greater than 7 cm DBH (dead tree). Table 16 also shows association of species richness with estimated height and DBH of overstory trees. Species richness was not significantly correlated with any of these vegetation components, which may indicate that species richness is driven by some other non-measured environmental variable such as food supply. On the other hand, perhaps the vegetation data in shrub/pole plots were too finely defined divided, so that species richness is due to a simple factor such as percent shrub cover.

In a principal component analysis, the first three principal components explained 63.9% of the total variance in the vegetation variables. Principal component (PC) I (stratification or vertical structural diversity) explained 31.4%, while PC II (open cover or amount of grass cover) counted for an additional 19.1% of the variance), and PC III (% shrubs) explained the additional 13.4%. The most significant factor explaining avian species richness among ecotone habitats in the breeding season was vertical structural diversity ($R^2 = 0.91$, $p < 0.001$). The influence of horizontal and vertical vegetation structure on bird communities is well studied (Brown 1992). Natural and human-induced disturbances play significant roles in structuring habitat and bird communities (Mushinsky and Gibson 1991). Disturbance caused by mining may create a mosaic of suitable niches and, like silvicultural disturbance, it may mimic the natural-intensity disturbance regime by creating habitat features required by open grassland and shrub species. In addition, edge habitat bordering mine land is suitable for many forest interior species linking a continuum of grassland, shrub, and forest species in the same general area.

Historical Dataset

Table 17 shows variables (percent slope and vegetation components) measured on 12 historical contour and seven MTRVF mines in southern West Virginia. These 12 contour and seven MTRVFs were randomly selected (among the 80 surveyed historical sites) for assessing vegetation because we could not quantify vegetation at all 80 sites. Vegetation was similar on these historical sites to those on the EIS MTRVFs, but contour mines were generally steeper, smaller in size, and had more advanced stages of succession.

Point count data pooled for all the historical sites showed that species richness was higher along edges 13.41 (± 0.88 SE) than interior plots (9.29 ± 0.69). This was a significant difference (paired t-test, $t = 93.7$, $p < 0.001$). The most abundant species on the 80 mine sites we have examined since 1987 were mostly shrub and forest-dwelling species (Canterbury et al. 1996, Canterbury and Stover 1999). These include, for example, Eastern Towhee, Golden-winged Warbler, and Field Sparrow of the edge / shrub guild, and the Red-eyed Vireo, Ovenbird, and Black-and-White Warbler of the forest-interior guild.

In this report, we compare bird populations at three of the historical sites (Peachtree Ridge, Highland Mountain and Whitby) where we have concentrated our efforts and produced GIS maps (see below). The number of individuals of the 15 most abundant bird species at these sites are listed in Canterbury and Stover (1999). The most abundant species was the Red-eyed Vireo (98 males per 100 ha.), which is considered a forest-interior species. This was followed by the Eastern Towhee, a habitat generalist of edge and shrub (79 males per 100 ha.). The imperiled Golden-winged Warbler was the third most numerous species at 77 males per 100 ha. Another forest-species, the Ovenbird, ranked fourth at 68 males per 100 ha. The Indigo Bunting (edge specialist) and the Black-and-White Warbler (forest-dwelling species) ranked fifth, with 52 males per 100 ha. for both species. Of the remaining 9 species, we found Chestnut-sided Warbler (shrub specialist, 44 males per 100 ha.), Hooded Warbler (forest-interior species, 39 males per 100 ha.), Field Sparrow (edge specialist, 36 males per 100 ha.), Yellow-breasted Chat (shrub specialist, 35 males per 100 ha.), Gray Catbird (shrub species, 27 males per 100 ha.), Wood Thrush (forest-interior species, 26 males per 100 ha.), Common Yellowthroat (shrub specialist, 24 males per 100 ha.), American Redstart (forest generalist, 23 males per 100 ha.), and Tufted Titmouse (forest generalist, 14 males per 100 ha.). Thus, five forest-interior species are rather abundant on these mine types.

Avian population trends from 1989-2000 in 32 southern West Virginia historical mine sites are shown in Table 18. Data were collected along SMC routes that consisted mainly of narrow contour mines surrounded by dense forest. Thus, the routes consisted of a combination of forest and mine habitats. Of the 15 most abundant species mentioned above, seven exhibited negative population trends and eight showed positive trends (Table 18). Of those with negative trends, four were significant. The three with nonsignificant downward trends were the Golden-winged Warbler (0.25% per yr.), Ovenbird (2.3% per yr.) and Common Yellowthroat (1.3% per yr.). The Golden-winged Warbler has shown a steep decline throughout its range since 1966 (7.6% per yr., Sauer et al. 2000), has virtually disappeared from Ohio (Peterjohn and Rice 1991) and the New England states (Confer 1992), and is considered to be declining in West Virginia, having dropped by 4.8% per year from 1966-1987 (BBS data cited in Buckelew and Hall 1994).

The Ovenbird has shown negative local and regional trends, but is not in an overall decline throughout its range (Sauer et al. 2000). Research has shown it is highly impacted by fragmentation throughout its range, but increased by about 18% in the Northeast during the 1994-1995 seasons (DeSante et al. 1998) and increased annually by 2.3% from 1966-2000 in West Virginia (Sauer et al. 2001). Although the Ovenbird is sensitive to habitat fragmentation (Robbins et al. 1989), it does occupy small (about 1 ha) forests tracts and is most likely not declining in West Virginia (BBS data cited in Buckelew and Hall 1994, Sauer et al. 2001). Yet, pairing success has been shown to increase away from edges in Missouri (Gibbs and Faaborg 1990, Villard et al. 1993, Van Horn et al. 1995), southern Ontario (Burke and Nol 1998), and Vermont (Ortega and Capen 1999). Missouri is a highly fragmented landscape (Geissman et al. 1986) and at the periphery of the Ovenbird s breeding range (Villard et al. 1993), and studies (see Sabine et al. 1996) in heavily forested landscapes contradict those of Gibbs and Faaborg (1990), Villard et al. 1993, and Van Horn (1995). Clearly, the data are mixed and contradictory for this well-studied, forest-interior species.

The shrub species are not as well studied as forest-interior species. Some relatively abundant and wide-ranging shrubland birds are declining. For example, the Common Yellowthroat has shown negative populations trends in West Virginia (BBS data cited in Buckelew and Hall 1994) and virtually rangewide (Sauer et al. 2000). Significant negative trends were noted in the Chestnut-sided Warbler (4.5% per yr.), Yellow-breasted Chat (3.5%), and Field Sparrow (7.3%) in our study sites in southern West Virginia (Table 18). Statewide BBS data have suggested that the Chestnut-sided Warbler is increasing in West Virginia, while the Yellow-breasted Chat and Field Sparrow have shown rangewide declines (BBS data cited in Buckelew and Hall 1994, Sauer et al. 2001). The only significant decline of forest-interior species of the most abundant 15 species at our southern West Virginia sites was the Hooded Warbler (4.3% per yr.), which is probably related to negative impacts of deer (Canterbury 2000a). Nonsignificant positive trends were noted in the Indigo Bunting (2.4% per yr.) and the Eastern Towhee (0.95% per yr.). Both these edge / shrub species, however, appear to be declining in many areas of their range (BBS data cited in Buckelew and Hall 1994, Sauer et al. 2000). Notable declines in the Eastern Towhee population are discussed in Hagan (1993).

Significant increases in the Tufted Titmouse (7.2% per yr.), Wood Thrush (3.0%), Gray Catbird (5.0%), Red-eyed Vireo (6.5%), Black-and-White Warbler (4.8%), and American Redstart (6.0%) were noted in southern West Virginia (Table 18). All of these are forest species, except the Gray Catbird. Further examination of Table 18, however, showed that there are some additional negative trends in forest-interior species. The Red-shouldered Hawk declined by 3.4% and Broad-winged Hawk by 10.8%. The Kentucky Warbler has declined by 7.5% in southern West Virginia and local extirpation of some populations has been noted (Canterbury, unpubl. data). There are numerous forest species that appear to be showing positive trends, and a significant number of shrub species are declining.

Figure 9 shows GIS maps for three historical sites (Peachtree Ridge, Highland Mountain, and Whitby). For each site, we have displayed (1) types of land cover, (2) location of roads, (3) location of water, (4) the distribution of elevation, (5) percent slope, and (6) location of houses. One feature displayed by these sites is that they are remote with relatively little fragmentation due to houses, except for a small cluster of houses in the Whitby area. This is believed to be an important factor in contributing to the relatively high densities of both shrub and forest-dwelling species (Canterbury and Stover 1999). Highland Mountain is the most forested of the three sites and had the highest number of Ovenbirds (88 males per 100 ha. as compared to 83 males per 100 ha. at Peachtree Ridge and 33 males per 100 ha. at Whitby). A similar trend holds for Black-and-White Warblers (63, 45, and 47 males per 100 ha. at Highland Mountain, Peachtree Ridge, and Whitby, respectively). However, Highland Mountain also had the highest density of Chestnut-sided Warblers, a shrubland species (Canterbury and Stover 1999). Peachtree Ridge had a higher percentage of total land cover disturbed by mining (Figure 9), but had the highest densities of the Wood Thrush, Red-eyed Vireo, and American Redstart (Canterbury and Stover 1999). Succession at Peachtree Ridge is older (Table 4). All three sites had about equal densities of Golden-winged Warblers (Canterbury and Stover 1999). Elevation and percent slope have been shown to be important predictors of the number of birds of some species, such as the Golden-winged Warbler, on contour and partial mountaintop mine sites (Canterbury et al. 1996, Canterbury and Stover 1999, Stover and Canterbury, in press). A sample of stepwise multiple regression models used to predict abundance of five shrub species is shown in Table 19. Similar analyses for forest-species are needed, such as the ongoing work by Rosenberg et al. (2000) on Cerulean Warblers.

The Cerulean Warbler is considered to be an area-sensitive forest species (Robbins et al. 1989, Rosenberg et al. 2000), but in southern West Virginia there is apparently no increase in number of birds in interior vs. edge plots and more Cerulean Warblers were found on contours than MTRVFs (Table 20, Canterbury 2000c). The Cerulean Warbler, however, is difficult to assess with point counts and Jones et al. (2000) recommend the variable circular plot method. The relatively large number of singing, male Cerulean Warblers in edge habitats may be predominantly first-time breeders (Canterbury 2000c), and area-sensitive species may not show negative impacts of forest fragmentation in moderately or heavily forested landscapes (Rosenberg et al. 1999b). Nevertheless, the Cerulean is a critically imperilled songbird (Robbins et al. 1992) and declined across its range by 2.7% per yr. from 1966-1991 (Peterjohn et al. 1996). Current estimate now is -3.5% per year from 1966-1999 (Sauer et al. 2000). Thus, additional work is needed where Cerulean and Golden-winged Warblers coexist, and where forest-interior and shrubland birds overlap breeding territories (Canterbury et al. 1996, Canterbury 2000c).

Figure 10 shows examples of bird density vs. distance from edge for three forest-interior and three shrub/edge species. In one case, the Ovenbird increased much more dramatically away from edges than did the Acadian Flycatcher and Kentucky Warbler, while shrub/edge species (Indigo Bunting, Eastern Towhee, and Northern Cardinal) declined toward the interior of a habitat. The Kentucky Warbler increased in number in interior forest as compared to edge (Figure 10), but has relatively high nesting success (73% of 22 nests successfully fledged young from 1987-1996) in edges not over-browsed by White-tailed deer (Canterbury and Stover, unpubl. data). Negative impacts of deer populations on understory nesting songbirds are growing (Casey and Hein 1983, Alverson et al. 1988, McShea and Rappole 1992, DeCalesta 1994, McShea et al. 1995).

Before we can adequately evaluate the impacts of mining on bird populations, data from multiple methods (e.g., song counts and mist-netting) must be considered. Tables 21 and 22 show samples of these data from TRMO (historical data and not MTRVF EIS sites), where guild abundance is compared between edge and interior plots as well as between methods (counts and mist-netting). Mist-netting produced more detections and the only guild with higher abundance in the forest interior was the bark-foraging guild (Table 21). Comparing the number of birds captured, we find that considerably more shrubland bird species were detected in a primarily forested habitat than in the other two habitats and by far the smallest number of captures were in grasslands (Table 22). It should be noted, however, that no canopy nets were used and these results would likely differ if canopy netting was conducted (see Stokes et al. 2000).

Summary

This report documents bird populations along edges at three large MTRVFs in southern West Virginia, and presents a comparison between bird populations along contour and MTRVF mines. The report incorporates 14 years of data from a long-term analysis of bird populations throughout the southern West Virginia coalfields. The report documents that, for the most part, both forest-interior and disturbance-dependent species are doing fairly well in the southern West Virginia coalfields. Yet, there are some exceptions and the decline of forest species such as Kentucky Warbler is of concern. We found the highest avian abundance in shrub/forest fragment ecotones in the MTRVF EIS sites, but some key forest-species, such as the Louisiana Waterthrush and Kentucky Warbler were in low numbers or missing from edges on the MTRVFs. Land use patterns in West Virginia are most likely why we have some of the best, if not the highest, concentrations of two umbrella species (Golden-winged and Cerulean warblers). The topology of West Virginia with large forests tracts with minimal disturbance (e.g., gaps, contour mine edges) may be why this is the only state that we know of that can claim to support vast populations of these two umbrella species. Yet, MTRVF mining has become a major method of vast landscape change, where Golden-winged and Cerulean warblers may disappear with the changing proportion of mature forest to cleared land. Both species are apparently doing much better on contour mines than MTRVFs, and this study documents that MTRVFs are considerably different from contour mines. Contour mining is not nearly as common as once was in the 1960s, for example, and has virtually been replaced by MTRVF mining. This may explain why these umbrella species are declining in West Virginia. Less individuals of these two umbrella species are returning each year to breed in West Virginia because of the advancing succession of contour mines and may be settling into areas where forest-contour mine edges are now suitable for breeding. This may explain why Tennessee, for example, has seen an increase in Golden-winged Warblers recently (anecdotal evidence seen throughout ListServs, *North American Birds*, *Birdscope*, and personal communications).

Recent declines in songbird populations have generated much concern in the lay and scientific community and sparked considerable research that has disclosed serious declines of interior forest species. A large number of studies have documented a correlation between decline of forest-interior bird species and edges (Wilcove 1985, Andrén and Angelstram 1988, Harris 1988, Martin 1988, Ratti and Reese 1988, Yahner 1988, Yahner and Scott 1988, Porneluzi et al. 1993, Paton 1994, Hoover et al. 1995, Linder and Bollinger 1995, Marini et al. 1995, Bayne and Hobson 1997, Donovan et al. 1997, Hartley and Hunter 1998, Keyser et al. 1998). Neotropical migrants have received the most attention thus far, but several studies have shown that patterns of population tends vary by geographic region and landscape pattern. The greater decline of Neotropical migrants compared to temperate migrants or residents has been well documented for Eastern forest-dwelling species during the last two decades (Robbins et al. 1989, Sauer and Droege 1992, Peterjohn and Sauer 1994b). However, there is evidence that non-forest breeding birds should be of even greater concern in some areas (Sauer and Droege 1992, James et al. 1992, Witham and Hunter 1992). Growing evidence suggests widespread, steep declines in grassland and shrub-breeding species (Knopf 1994, Vickery and Herkert 1999), and that temperate migrants are declining in equal or greater proportion to Neotropical migrants in some areas and habitats (Hagan et al. 1992, Witham and Hunter 1992, Bohning-Gaese et al. 1993). In West Virginia and elsewhere, there is considerable variation in population decline among forest, shrub, and grassland bird groups (Hall 1983, BBS data cited in Buckelew and Hall 1994, Sauer et al. 2001).

Examination of avian abundances across seasons shows that species relative abundance and species richness are generally highest in shrub habitats. We found that abundances of birds varied among the MTRVF edge types studied. The documentation of the occurrence of fairly good numbers of forest interior species along edge habitats, especially contour shrub edges bordering mature forest is nothing new to West Virginia ornithology (see Canterbury et al. 1996 and Canterbury and Stover 1999). This study documents that many bird species occur predominantly in shrub/forest fragment ecotones. Historical (and long-term) data collected since 1987 throughout southern West Virginia indicate that there is little evidence of negative impacts of forest fragmentation on relative abundance of most forest-dwelling birds, such as the Acadian Flycatcher, Wood Thrush, and Black-and-White Warbler. Despite centuries of habitat fragmentation, the population status and relatively high densities of eastern, forest-dwelling birds throughout their range support this assertion. Advancing forest succession and landscape-induced factors (highly forested states such as West Virginia and other areas throughout eastern North America) probably play important roles in regulating forest species populations. Most likely, we experience local declines of forest species in some areas and increasing, expanding source populations in others. The Acadian Flycatcher is the most numerous bird banded in highly fragmented forest patches during the breeding season in northeastern Ohio (J. Pogacnik, unpubl. data), and increasing in northern Ohio (Canterbury, unpubl. data), despite an annual 1.2% decline in West Virginia from 1966-2000 (Sauer et al. 2001). The Wood Thrush was found in about equal numbers throughout the forested ecotones of this study (Table 10), while the Black-and-White Warbler appears to be increasing in West Virginia and not impacted by deer herbivory.

A group of ground-nesting forest-species, including the Kentucky and Worm-eating warblers, appear to be declining and this may be due to impacts of deer herbivory. This is contradictory to that mentioned above for the Black-and-White Warbler, which has similar nesting habits to the Worm-eating Warbler. Microhabitat differences and ecological competition may explain why some ground-nesting birds of the deciduous forest are declining, while others are increasing.

The most significant analysis may be of priority species identified by Partners In Flight as in need of further study and conservation, and are declining significantly throughout much of their range. Table 23 shows priority species for the study area (Northern Cumberland Plateau Physiographic Province of West Virginia) and list nationally the species on the Watch List. At the national and local level, the Cerulean Warbler (hardwood and mixed mature forest guild) and Golden-winged Warbler (shrub-scrub guild) are of extremely high concern because of their continental population declines. The landscape pattern with the most birds, namely large forested areas with small edges or minimal disturbance from contour mines should be evaluated for a management option for these two species. Of the species of high priority for the hardwood and mixed mature forest of the Northern Cumberland Plateau, namely the Acadian Flycatcher, Yellow-throated Vireo, Wood Thrush, Yellow-throated Warbler, Worm-eating Warbler, Ovenbird, Louisiana Waterthrush, Kentucky Warbler, and Hooded Warbler, two are declining significantly and the others are increasing. The two with an overall continental decline are the Wood Thrush and Kentucky Warbler.

The highest priority bird species, other than the Golden-winged Warbler, in this region are forest-breeders (Cerulean Warbler, Worm-eating Warbler, and Louisiana Waterthrush) whose center of global abundance is along the Appalachian ridges most affected by MTRVF mining (Rosenberg and Wells 1995). Because the Golden-winged Warbler is apparently not being replaced by its sister species in MTRVFs (it would not occur on the Cannelton site, which is in an area that has experienced Blue-wing invasion since the late 1950s), focus should be directed mainly on the forest-interior species.

In closing, in our study of bird populations of southern West Virginia coalfields, we found that the highest avian richness and abundance occurred in shrub/pole habitat on MTRVFs and other mine types in southern West Virginia and that species diversity and abundances varied with edge type. The clearing of forests often results in edge effects, in which species diversity and densities are often higher than in interior forest (see Lay 1938, Johnston 1947, Anderson et al. 1977, McElveen 1979, Strelke and Dickson 1980). The considerable amount of edge created by MTRVF mining is apparently no exception to this pattern, but critical studies are needed to assess additional parameters, such as nesting success, before we make final decisions about the impacts of MTRVF. This is especially true since our work suggest that MTRVF edges differ from those heavily studied in the literature for which considerable impacts due to forest fragmentation have been documented. This study also does not consider any impacts of tropical deforestation on declining Neotropical migrants, nor does it consider the impacts of Brown-headed Cowbirds. Finally, this study, like all those conducted on forest fragmentation, should be evaluated in respect that numerous studies have documented the adverse effects of forest fragmentation.

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Table 1. Total land cover (ha.) of available habitats within MTVRV sites used in this study and percent secondary succession that resulted from reclamation of contour mining rather than MTRVF.

Habitat	Cannelton	Hobet 21	Daltex
Grassland	1,673	2,003	1,835
Shrub/pole	510 [a]	428	296 [a]
Forest Fragment	291	339	125
Total [b]	2,474	4,394	2,834
% Contour Mine	44%	17%	25%

[a] produced mainly by reclamation of contour mining.
[b] includes additional habitats other than the three treatment habitats shown.

Table 2. Distribution of 134 edge points per habitat and MTRVF site (watershed) in southwestern West Virginia.

Ecotone	Cannelton (Twentymile Cr.)	Daltex (Spruce Fork)	Hobet 21 (Mud River)	Total
Grassland / forest	2	17	17	36
Grassland / fragment[1]	25	3	10	38
Grassland / pole[2]	11	12	7	30
Pole / fragment[1]	6	10	14	30
Total	44	42	48	134

[1] = forest fragment, [2] = reclaimed pole-size succession

Table 3. Number of points (N) per watershed / stream in the MTRVF sites of southwestern West Virginia.

Watershed / Stream	Mine Site	N
Adkins Fork	Hobet 21	4
Beech Creek	Daltex	10
Big Horse Creek	Hobet 21	1
Bullpush	Cannelton	13
Gum Hollow	Hobet 21	5
Hewett Creek	Daltex	12
Horse Branch	Hobet 21	3
Hughes Fork	Cannelton	5
Hurricane Branch	Daltex	3
Jim Hollow of Hughes Fork	Cannelton	6
Lavender Fork	Hobet 21	6
Left Fork of Beech Creek	Daltex	3
Little Horse Creek	Hobet 21	5
Lynch / Smithers Creek	Cannelton	15
Rockhouse Fork	Daltex	12
Sally Fork	Hobet 21	6
Sixmile Hollow of Hughes Creek	Cannelton	5
Slippery Gut Branch	Hobet 21	4
Spruce Fork	Daltex	2
Spruce Lick	Hobet 21	4
Stanley Fork	Hobet 21	3
Sugartree Branch	Hobet 21	7

Table 4. Sample of historical mine sites examined during an on-going, long-term analysis of edge and shrub habitats in southern West Virginia.[a]

Mine	County	Coordinates[b] and Topo	Mine Type[c]	Years Studied	Size (ha)[d]	Mine Age[e]	Elev. (m)[f]
Ameagle (Mare Br.)	Raleigh	37° 56' 49" N 81° 22' 55" W Pax	Contour	12	14.8	1989	690
Artie (White Oak Creek)	Raleigh	37° 55' 53" N 81° 18' 22" W Pax	Mixed	9	91	1980	732
Bee & Georges Br. (Shotgun Hollow)	Fayette	37° 55' 43" N 81° 16' 57" W Pax	Contour MTRVF	5	97.2	1986 1995	629
Berry Branch	Raleigh	37° 40' 00" N 81° 17' 30" W Lester	MTRVF	1	150.7	1999	700
Beury Mt.	Fayette	37° 57' 24.7" N 81° 03' 45.8" W Thurmond	Mixed	12	33	1965	755
Big Branch	Wyoming	37° 45' 30.7" N 81° 27' 16.0" W McGraws	Contour	7	105	1985	758
Big Creek	McDowell	37° 16' 47.4" N 81° 34' 43.4" W Gary	Contour	1	97	1968	725
Bottom Creek	McDowell	37° 25' 47.4" N 81° 28' 17.5" W Keystone	Contour	1	43.7	1972	669
Brooklyn (Chestnut Flat)	Fayette	37° 34' 26" N 81° 02' 30" W Thurmond	Mixed	3	63	1980	685
Buffalo Fork	Raleigh	37° 53' 23" N 81° 17' 40" W Pax	MTRVF	5	120.2	1992	600

Table 4. Continued.

Cooperstown	Boone	38° 05' 18" N 81° 35' 11" W Sylvester	Mixed	13	39	1976	490
Crab Orchard (Thompson Ridge)	Raleigh	37° 42' 10" N 81° 14' W Crab Orchard	MTRVF	4	79.6	1970	723
Crane Creek	Wyoming	37° 45' 33.4" N 81° 31' 22.7" W Arnett	Contour	5	37.6	1969	964
Cunard	Fayette	37° 58' 29.1" N 81° 02' 25.1" W Fayettville	Mixed	12	88.5	1969	723
Dry Creek	Boone	37° 49' 44" N 81° 31' 41" W Pilot Knob / Arnett	PMTRVF	5	15.7	1994	700
East Gulf (Stonecoal Cr. & Willibet)	Raleigh	37° 37° 28" N 81° 11' 08" W Rhodell	Contour	12	83	1983	690
Eccles (Millers Camp Branch)	Raleigh	37° 46' 39.1" N 81° 15' 52.5" W Eccles	Contour	14	68.5	1983	703
Egeria	Mercer	37° 30' N 81° 12' W Odd	Contour	8	51.6	1974	879
Ellison Br.	Fayette	37° 54' 56.8" N 80° 53' 58.1" W Danese	Contour	4	47.3	1972	703
Ellis Creek (Marsh Fork)	Raleigh	37° 55' 37" N 81° 29' 32" W Whitesville / Dorothy	PMTRVF	6	10.2	1993	475

Table 4. Continued.

Ephraim Cr.	Fayette	37° 57' 02.5" N 80° 52' 59.3" W Danese	PMTMVF	5	48.6	1975	747
Garden Ground Mt.	Fayette	37° 54.4' N 81° 05.7' W Thurmond	Contour	12	159	1965	749
Gary	McDowell	37° 18' 50.2" N 81° 33' 09.2" W Gary	Mixed	3	370	1970	780
Ghent	Raleigh	37° 37' 10" N 81° 06' 43" W Flat Top	Contour	12	31.7	1972	903
Gilbert (Rich Creek)	Logan	37° 40' 55" N 81° 56' 10" W Gilbert	MTRVF	2	35	1998	570
Glen Rogers	Wyoming	37° 45' 33.2" N 81° 26' 45.4" W Glen Rogers	PMTMVF	3	85.9	1985	741
Guyandotte (Bolt) Mt.	Raleigh / Wyoming	37° 47' 10" N 81° 29' 48" W Arnett	Contour	12	28.5	1969	970
Harper	Raleigh	37° 48' 33" N 81° 15' 07" W Beckley / Eccles	Contour	14	2.5	1983	690
Harpers Br. (Sandlick Cr.)	Raleigh	37° 49' 25" N 81° 19' 56" W Eccles	Mixed	14	52.4	1983	712
Hazy Creek	Raleigh	37° 51' 17" N 81° 33' 24" W Pilot Knob	Contour	14	39.4	1987	722
Highland Mt.	Fayette	37° 55.3' N 81° 0.6' W Thurmond	MTRVF	11	108	1973	742

Table 4. Continued.

Kayford Mt.	Boone / Raleigh	37° 58' 23.1" N 81° 22' 09.9" W Whitesville	MTRVF	9	1,862	1971	746
Horse Creek	Raleigh	37° 55' 44" N 81° 19' 45" W Pax	Contour MTRVF	12	180	1987 1999	590
James Creek	Boone	37° 55' 27" N 81° 33' 53" W Whitesville	MTRVF	1	538	1999	600
Laurel Br. (Big Coal River)	Raleigh	37° 57 49" N 81° 27" 16" W Dorothy	Contour	5	6.84	1994	478
Lester	Raleigh	37° 44' 10" N 81° 17' 30" W Lester	Contour	12	20.4	1975	715
Lick Creek	Raleigh	37° 56' 05" N 81° 19' 29" W Pax	PMTRVF	6	42.5	1988	730
Little Brushy Fork (Little Marsh FK.)	Raleigh	37°55' 08" N 81° 29' 10" W Dorothy	Mixed	1	25.6	1999	591
Lillybrook	Raleigh	37° 38' 15.3" N 81° 13' 03.1" W Crab Orchard	PMTMVF Auger	8	63.8	1969 1998	697
Long Creek	Fayette	37° 57' 08.2" N 80° 52' 34.9" W Danese	Contour	2	71	1972	715
Low Gap Br. (Coon Hollow - Dorothy)	Raleigh	37° 56' 33" N 81° 30' 15" W Dorothy / Whitesville	Mixed	6	28	1993	602
Mann Mt.	Fayette	38° 02' 44.4" N 80° 53' 30.9" W Danese	MTRVF	7	82	1978	746

Table 4. Continued.

Manns Creek	Fayette	37° 59' 44.1" N 80° 53' 22.4" W Danese	MTRVF	4	150	1973	729
Maple Meadow	Raleigh	37° 45' 29.8" N 81° 21' 53.1" W Lester	Contour	14	133	1969	591
McAlpin	Raleigh	37° 41' 50" N 81° 17' 17" W McAlpin	Contour	12	60.2	1983	703
McDowell Branch	Raleigh	37° 54' 24" N 81° 22' 28" W Pax	MTRVF	12	28.5	1983	585
Meadow Fork	Fayette	37° 55' 31" N 81° 06' 10" W Thurmond	Contour	12	79.1	1966	725
Metalton	Raleigh	37° 46' 35" N 81° 17' 17" W Eccles	Contour	14	73.3	1974	602
Midway	Raleigh	37° 42' 40" N 81° 13' 41" W Crab Orchard	Contour	12	32.7	1982	600
Mill Creek	Raleigh	37° 51' 41.4" N 81° 08' 42.7" W Oak Hill	Contour	3	63.9	1969	664
Millers Fork	Raleigh	37° 48' 43" N 81° 27' 01" W Arnett	Contour	12	6.3	1982	587
Mount Hope (Sun Mine Rd.)	Fayette	37° 55' 28" N 81° 10' 37.6" W Oak Hill	Mixed	2	90	1983	609
Muddlety	Nicholas	37° 17' 21.4" N 81° 49' 43" W Summersville	MTRVF	7	219	1988	721

Table 4. Continued.

Odd (Piney Cr.)	Raleigh	37° 36' 43.5" N 81° 10' 24.0" W Odd	Contour	6	37	1972	848
Panther Br. (Clear Fork)	Raleigh	37° 56' 53" N 81° 27' 36" W Dorothy	Contour	6	20.6	1990	590
Payne Knob (Paint Creek)	Fayette	38° 00' 26" N 81° 19' 06" W Pax	MTRVF	3	59	1991	822
Peachtree Ridge	Raleigh	37° 50' 27.0" N 81° 28' 18.7" W Arnett	Contour	12	160	1962	939
Pinnacle Cr.	Wyoming	37° 33' 24" N 81° 29' 09" W Pineville	MTRVF	5	135	1979	856
Princewick (Stonecoal Creek)	Raleigh	37° 40' N 81° 15.7' W Crab Orchard	Contour	3	38	1966	727
Rock Creek (Left Fork)	Raleigh	37° 52' 22" N 81° 22' 25" W Arnett	PMTRVF	12	23.6	1981	579
Scarbro	Fayette	37° 50' 36" N 81° 10' 34" W Oak Hill	Contour	12	13	1983	600
Seng Creek	Boone	37° 59' 06" N 81° 37' 02" W Whitesville	MTRVF	3	49	1977	523
Shumate Creek	Raleigh	37° 51' 19" N 81° 31' 36" W Pilot Knob	Contour	7	28.7	1996	725
Slab Fork (Mill Branch)	Raleigh	37° 40' 34.7" N 81° 19' 12.0" W Lester	Contour	5	375	1973	689

Table 4. Continued.

Stover (Sandlick)	Raleigh	37° 50' 39" N 81° 20' 00" W Eccles	Mixed	8	171.3	1978	526
Sweenyburg	Raleigh	37° 50' 20" N 81° 15' 41" W Eccles	Contour	13	5.5	1988	550
Sycamore Creek	Raleigh	37° 52' 33" N 81° 23' 02" W Pax	MTRVF	13	37.2	1983	531
Table Rock	Raleigh	37° 47' 12" N 81° 02' 40" W Prince	Contour	12	56	1977	848
Tams	Raleigh	37° 40' 20" N 81° 18' 06" W	Contour	13	5.6	1983	700
Tams Creek (Paint Mt.)	Raleigh	37° 56' 21" N 81° 17' 01" W Pax	PMTRVF	5	8	1991	769
Tiller Camp Branch (Devil s Fork)	Raleigh	37° 33' 32" N 81° 16' 46" W Rhodell	Mixed	8	3.5	1990	605
Tommy Cr.	Raleigh	37° 35' 41" N 81° 14' 52" W Rhodell	Contour	12	24.5	1985	500
Toney Fork	Raleigh	37° 54' 48" N 81° 18' 04" W Pax	MTRVF	9	106.7	1989	800
Welch	McDowell	37° 24' 54" N 81° 33' 30" W Welch	MTRVF	6	77	1974	587
West Fork (Pond Fork)	Boone / Raleigh	37° 54' 51" N 81° 36' 02" W Whitesville	MTRVF	12	137	1988	500

Table 4. Continued.

White Oak Creek	Boone	37° 08' 40.9" N 81° 30' 42.9" W Whitesville	Mixed MTRVF	3	147	1985 1995	597
Whitby (Spencer Br.)	Raleigh	37° 39' 48.3" N 81° 10' 37.0" W Crab Orchard	Contour	12	175	1974	712
Workmans Creek	Raleigh	37° 53' 17" N 81° 21' 43" W Pax	MTRVF	13	142	1983	699

[a] Additional sites can be obtained from the senior author, including vast areas with old contour mining activity such as Rhodell, Raleigh County. These sites are also described in Canterbury et al. 1993, 1996, Canterbury and Stover 1999 and 2000c. [b] Center of the study area and empty blocks denote coordinates not yet obtained. [c] Primary mining method (see Canterbury and Stover 1999). [d] Land originally disturbed by mining activity (but 79% of this land is now second-growth forest). [E] Date of earliest surface mining activity, but permits may span several decades. [f] Modal value.

Table 5. Relative abundance (number/point) of birds observed during the winter season (January - April 10, 2000) at interior (n = 80) and edge (n = 134) points at MTRVFs of southwestern West Virginia.

	Interior	**Edge**
Species	**± 1 SE**	**± 1 SE**
American Crow	0.82 ± 0.27	3.04 ± 1.09
American Goldfinch	0.08 ± 0.02	0.08 ± 0.02
American Kestrel	0.00 ± 0.00	0.10 ± 0.03
American Robin	0.10 ± 0.06	0.70 ± 0.30
American Tree Sparrow	0.0 ± 0.0	0.12 ± 0.04
American Woodcock	0.0 ± 0.0	0.05 ± 0.02
Belted Kingfisher	0.0 ± 0.0	0.01 ± 0.005
Black-capped Chickadee	0.0 ± 0.0	0.03 ± 0.009
Blue Jay	0.12 ± 0.07	0.07 ± 0.02
Brewer s Blackbird	0.0 ± 0.0	0.01 ± 0.005
Brown-headed Cowbird	0.0 ± 0.0	0.05 ± 0.03
Canada Goose	0.0 ± 0.0	0.08 ± 0.05
Carolina Chickadee	0.27 ± 0.10	0.19 ± 0.08
Carolina Wren	0.10 ± 0.04	0.21 ± 0.09
Cedar Waxwing	0.14 ± 0.04	0.16 ± 0.05
Chipping Sparrow	0.02 ± 0.008	0.02 ± 0.008
Common Raven	0.0 ± 0.0	0.04 ± 0.01
Dark-eyed Junco	1.65 ± 0.72	1.87 ± 0.75
Downy Woodpecker	0.12 ± 0.05	0.17 ± 0.09
Eastern Bluebird	0.35 ± 0.12	1.13 ± 0.61

Table 5. Continued.

	Interior	Edge
Species	**± 1 SE**	**± 1 SE**
Eastern Meadowlark	0.10 ± 0.05	1.15 ± 0.63
Eastern Phoebe	0.00 ± 0.00	0.09 ± 0.03
European Starling	0.0 ± 0.0	2.27 ± 1.03
Field Sparrow	0.40 ± 0.11	0.80 ± 0.51
Golden-crowned Kinglet	0.02 ± 0.005	0.04 ± 0.02
Hairy Woodpecker	0.0 ± 0.0	0.04 ± 0.009
Hermit Thrush	0.12 ± 0.05	0.12 ± 0.04
Horned Lark	0.07 ± 0.03	0.65 ± 0.22
Killdeer	0.0 ± 0.0	0.29 ± 0.10
Mallard	0.12 ± 0.08	0.56 ± 0.20
Mourning Dove	0.07 ± 0.04	0.09 ± 0.04
Northern Cardinal	0.15 ± 0.07	0.22 ± 0.09
Northern Flicker	0.40 ± 0.18	0.64 ± 0.28
Northern Harrier	0.07 ± 0.04	0.17 ± 0.12
Northern Mockingbird	0.0 ± 0.0	0.04 ± 0.01
Peregrine Falcon[1]	---	---
Pileated Woodpecker	0.40 ± 0.16	0.23 ± 0.10
Red-bellied Woodpecker	0.02 ± 0.007	0.05 ± 0.01
Red-shouldered Hawk	0.04 ± 0.01	0.05 ± 0.009
Red-tailed Hawk	0.07 ± 0.02	0.17 ± 0.09
Red-winged Blackbird	0.22 ± 0.09	0.28 ± 0.10
Ring-necked Pheasant	0.0 ± 0.0	0.03 ± 0.01

Table 5. Continued.

	Interior	Edge
Species	**± 1 SE**	**± 1 SE**
Rock Dove	0.0 ± 0.0	0.07 ± 0.02
Rough-legged hawk	0.0 ± 0.0	0.03 ± 0.008
Ruby-crowned Kinglet	0.0 ± 0.0	0.04 ± 0.01
Ruffed Grouse	0.02 ± 0.01	0.03 ± 0.01
Sharp-shinned Hawk	0.05 ± 0.01	0.0 ± 0.0
Song Sparrow	0.37 ± 0.20	0.83 ± 0.31
Swamp Sparrow	0.0 ± 0.0	0.08 ± 0.05
Tufted Titmouse	0.32 ± 0.18	0.29 ± 0.18
Turkey Vulture	0.22 ± 0.10	0.70 ± 0.30
Vesper Sparrow	0.0 ± 0.0	0.12 ± 0.05
Water Pipit	0.0 ± 0.0	0.03 ± 0.009
White-breasted Nuthatch	0.17 ± 0.09	0.03 ± 0.01
White-throated Sparrow	0.12 ± 0.06	0.12 ± 0.06
Wild Turkey	0.0 ± 0.0	0.90 ± 0.41
Winter Wren	0.0 ± 0.0	0.02 ± 0.008
Wood Duck	0.15 ± 0.07	0.29 ± 0.14
Yellow-bellied Sapsucker	0.05 ± 0.02	0.0 ± 0.0
Gull species[2]	---	---

[1] Single bird observed on Cannelton mine. Incidental sightings (outside areas of point counts) included: Brown Thrasher, Bufflehead, Eastern Towhee, Golden Eagle, Greater Yellowlegs, Hooded Merganser, Lesser Yellowlegs, Marsh Wren, Ring-billed Gull, Rock Dove, and Savannah Sparrow. [2] = unidentified.

Table 6. Importance values (IV) of selected bird species in winter on MTRVFs.

Species	IV	Species	IV
High Occurence		**Low Occurence**	
American Crow	174	Turkey Vulture	44
Dark-eyed Junco	149	Wild Turkey	40
Moderate Occurence		American Robin	37
European Starling	97	Pileated Woodpecker	33
Eastern Bluebird	88	Horned Lark	29
Eastern Meadowlark	75	Mallard	27
Field Sparrow	63	Tufted Titmouse	24
Song Sparrow	63	Red-winged Blackbird	18
Northern Flicker	53	Carolina Chickadee	10

Table 7. Relative abundance (mean ± 1 SE) of birds detected along grassland, shrub, forest fragment, and intact forest transects within MTRVF EIS sites of southwestern West Virginia. Data collected during the spring and fall migration periods.

Species (by Habitat)	Spring Abundance	Fall Abundance
Grassland		
American Kestrel	0.10 ± 0.06	0.05 ± 0.006
Barn Swallow	0.51 ± 0.20	0.21 ± 0.10
Bobolink	0.21 ± 0.08	0.44 ± 0.18
Brown-headed Cowbird	0.13 ± 0.07	0.22 ± 0.10
Chimney Swift	0.29 ± 0.10	0.19 ± 0.12
Common Grackle	0.30 ± 0.10	0.33 ± 0.15
Common Nighthawk	0.01 ± 0.003	0.22 ± 0.12
Common Raven	0.06 ± 0.004	0.12 ± 0.05
Common Snipe	0.03 ± 0.005	0.04 ± 0.009
Eastern Bluebird	0.15 ± 0.08	0.24 ± 0.09
Eastern Kingbird	0.15 ± 0.09	0.23 ± 0.10
Eastern Meadowlark	0.57 ± 0.29	0.41 ± 0.22
European Starling	0.69 ± 0.30	0.40 ± 0.18
Grasshopper Sparrow	0.13 ± 0.07	0.58 ± 0.23
Great Blue Heron	0.08 ± 0.02	0.07 ± 0.04
Horned Lark	0.30 ± 0.18	0.40 ± 0.21
Killdeer	0.32 ± 0.19	0.20 ± 0.11
Mallard	0.12 ± 0.05	0.16 ± 0.05
Mourning Dove	0.43 ± 0.25	0.59 ± 0.30
Northern Harrier	0.06 ± 0.01	0.02 ± 0.009
Northern Rough-winged Swallow	0.29 ± 0.13	0.20 ± 0.09
Red-tailed Hawk	0.08 ± 0.04	0.03 ± 0.007

Table 7. Continued.

Species	Spring Abundance	Fall Abundance
Red-winged Blackbird	0.48 ± 0.23	0.38 ± 0.20
Rusty Blackbird	0.16 ± 0.06	0.0
Savannah Sparrow	0.25 ± 0.09	0.08 ± 0.04
Tree Swallow	0.61 ± 0.22	0.49 ± 0.25
Turkey Vulture	0.63 ± 0.22	0.92 ± 0.38
Vesper Sparrow	0.19 ± 0.09	0.0
Wood Duck	0.04 ± 0.003	0.0
Shrubland		
American Goldfinch	0.30 ± 0.12	0.45 ± 0.20
American Redstart	0.39 ± 0.17	0.10 ± 0.06
American Robin	0.59 ± 0.20	0.35 ± 0.16
American Woodcock	0.33 ± 0.19	0.06 ± 0.008
Baltimore Oriole	0.15 ± 0.06	0.12 ± 0.06
Bay-breasted Warbler	0.05 ± 0.02	0.15 ± 0.07
Black-billed Cuckoo	0.18 ± 0.10	0.23 ± 0.15
Blackpoll Warbler	0.02 ± 0.008	0.0
Blue Grosbeak	0.23 ± 0.13	0.08 ± 0.05
Blue-winged Warbler	0.59 ± 0.23	0.22 ± 0.12
Brown Thrasher	0.42 ± 0.19	0.28 ± 0.10
Carolina Wren	0.44 ± 0.21	0.33 ± 0.17
Cedar Waxwing	0.20 ± 0.13	0.09 ± 0.05
Chestnut-sided Warbler	0.20 ± 0.09	0.36 ± 0.15
Chipping Sparrow	0.59 ± 0.23	0.45 ± 0.19
Common Yellowthroat	0.40 ± 0.18	0.30 ± 0.18
Dark-eyed Junco	0.31 ± 0.17	0.0

Table 7. Continued.

Species	Spring Abundance	Fall Abundance
Eastern Phoebe	0.41 ± 0.21	0.35 ± 0.17
Eastern Towhee	0.46 ± 0.18	0.43 ± 0.20
Field Sparrow	0.68 ± 0.31	0.21 ± 0.10
Golden-winged Warbler	0.24 ± 0.14	0.11 ± 0.06
Gray Catbird	0.61 ± 28	0.55 ± 0.25
Great-crested Flycatcher	0.33 ± 0.19	0.11 ± 0.05
Hairy Woodpecker	0.20 ± 0.11	0.21 ± 0.08
House Finch	0.07 ± 0.03	0.0
House Wren	0.25 ± 0.10	0.25 ± 0.13
Indigo Bunting	0.45 ± 0.22	0.40 ± 0.19
Kentucky Warbler	0.08 ± 0.03	0.0
Least Flycatcher	0.17 ± 0.09	0.27 ± 0.15
Lincoln s Sparrow	0.10 ± 0.04	0.0
Magnolia Warbler	0.50 ± 0.21	0.29 ± 0.12
Mourning Warbler	0.18 ± 0.07	0.08 ± 0.05
Nashville Warbler	0.31 ± 0.13	0.21 ± 0.10
Northern Bobwhite	0.05 ± 0.001	0.02 ± 0.001
Northern Cardinal	0.33 ± 0.15	0.27 ± 0.14
Northern Flicker	0.39 ± 0.19	0.33 ± 0.15
Northern Mockingbird	0.12 ± 0.06	0.21 ± 0.09
Northern Waterthrush	0.13 ± 0.07	0.0
Orange-crowned Warbler	0.05 ± 0.01	0.0
Palm Warbler	0.16 ± 0.09	0.0
Pine Siskin	0.18 ± 0.07	0.0
Pine Warbler	0.12 ± 0.05	0.06 ± 0.02

Table 7. Continued.

Species	Spring Abundance	Fall Abundance
Prairie Warbler	0.40 ± 0.16	0.08 ± 0.04
Purple Finch	0.13 ± 0.06	0.0
Red-bellied Woodpecker	0.42 ± 0.22	0.40 ± 0.25
Red-headed Woodpecker	0.00	0.15 ± 0.09
Red-shouldered Hawk	0.15 ± 0.10	0.11 ± 0.007
Ruby-throated Hummingbird	0.20 ± 0.12	0.31 ± 0.15
Ruffed Grouse	0.30 ± 0.18	0.40 ± 0.23
Scarlet Tanager	0.46 ± 0.20	0.13 ± 0.05
Song Sparrow	0.38 ± 0.16	0.27 ± 0.10
Swamp Sparrow	0.14 ± 0.07	0.0
Tennessee Warbler	0.45 ± 0.20	0.63 ± 0.25
White-crowned Sparrow	0.16 ± 0.06	0.0
White-eyed Vireo	0.33 ± 0.17	0.65 ± 0.29
White-throated Sparrow	0.63 ± 0.27	0.0
Wild Turkey	0.63 ± 0.33	0.53 ± 0.29
Willow Flycatcher	0.31 ± 0.13	0.22 ± 0.12
Worm-eating Warbler	0.19 ± 0.08	0.13 ± 0.06
Yellow-breasted Chat	0.20 ± 0.08	0.11 ± 0.05
Yellow-billed Cuckoo	0.15 ± 0.04	0.29 ± 0.13
Yellow-rumped Warbler	0.52 ± 0.23	0.0
Yellow Warbler	0.31 ± 0.13	0.08 ± 0.04
Forest		
Acadian Flycatcher	0.56 ± 0.30	0.45 ± 0.20
American Crow	0.66 ± 0.28	0.49 ± 0.23
Barred Owl	0.06 ± 0.003	0.02 ± 0.001

Table 7. Continued.

Species	Spring Abundance	Fall Abundance
Belted Kingfisher	0.13 ± 0.07	0.25 ± 0.12
Black-and-White Warbler	0.30 ± 0.13	0.10 ± 0.04
Blackburnian Warbler	0.14 ± 0.05	0.09 ± 0.04
Black-throated Blue Warbler	0.12 ± 0.05	0.05 ± 0.01
Black-throated Green Warbler	0.31 ± 0.14	0.09 ± 0.03
Blue-gray Gnatcatcher	0.51 ± 0.23	0.28 ± 0.14
Blue Jay	0.46 ± 0.26	0.29 ± 0.12
Blue-headed Vireo	0.45 ± 0.20	0.08 ± 0.04
Broad-winged Hawk	0.16 ± 0.06	0.24 ± 0.13
Cape May Warbler	0.23 ± 0.09	0.19 ± 0.09
Carolina Chickadee	0.55 ± 0.21	0.61 ± 0.29
Cerulean Warbler	0.22 ± 0.12	0.0
Cooper s Hawk	0.05 ± 0.008	0.10 ± 0.004
Downy Woodpecker	0.59 ± 0.20	0.27 ± 0.14
Eastern Screech-Owl	0.09 ± 0.05	0.01 ± 0.004
Golden-crowned Kinglet	0.15 ± 0.04	0.0
Hermit Thrush	0.30 ± 0.18	0.0
Hooded Warbler	0.24 ± 0.12	0.14 ± 0.07
Louisiana Waterthush	0.14 ± 0.08	0.0
Northern Parula	0.16 ± 0.08	0.09 ± 0.05
Orchard Oriole	0.17 ± 0.08	0.05 ± 0.008
Ovenbird	0.35 ± 0.13	0.15 ± 0.09
Philadelphia Vireo	0.14 ± 0.06	0.09 ± 0.03
Pileated Woodpecker	0.18 ± 0.08	0.18 ± 0.08
Red-eyed Vireo	0.67 ± 0.26	0.51 ± 0.21

Table 7. Continued.

Species	Spring Abundance	Fall Abundance
Rose-breasted Grosbeak	0.15 ± 0.10	0.26 ± 0.12
Ruby-crowned Kinglet	0.29 ± 0.11	0.0
Sharp-shinned Hawk	0.02 ± 0.001	0.04 ± 0.001
Swainson s Thrush	0.32 ± 0.14	0.26 ± 0.12
Tufted Titmouse	0.31 ± 0.12	0.40 ± 0.18
Whip-poor-will	0.19 ± 0.08	0.0
White-breasted Nuthatch	0.22 ± 0.13	0.33 ± 0.15
Winter Wren	0.08 ± 0.01	0.0
Wood Thrush	0.63 ± 0.28	0.20 ± 0.12
Yellow-bellied Sapsucker	0.27 ± 0.15	0.0
Yellow-throated Vireo	0.17 ± 0.11	0.28 ± 0.14
Yellow-throated Warbler	0.20 ± 0.09	0.06 ± 0.02

Additional sightings: American Bittern, American Black Duck, American Coot, King Rail, Pied-billed Grebe, Solitary Sandpiper, and Spotted Sandpiper were on or near ponds in grasslands. Ringed-necked Pheasants were seen in grassland and shrub/pole habitats.

Table 8. Mean (± SE) avian species richness and total abundance along 300 meter line transects (50 meters fixed width) within four edge habitat types of the MTRVF sites in southwestern West Virginia. Data were compiled from spring migration counts from April 11 - May 31, 2000.

	Grassland	Shrub	Forest (fragment)	Forest (intact)	F^2 (p)
Species (within 50 meters)	12.31 ± 0.93	18.58 ± 1.29	9.16 ± 0.85	7.23 ± 0.49	38.5 (0.01)
Density[1] (within 50 meters)	8.35 ± 0.51	12.39 ± 0.83	6.59 ± 0.44	5.10 ± 0.40	32.0 (0.02)
Total Abundance	23.85 ± 1.3	30.98 ± 1.05	19.27 ± 1.12	12.34 ± 0.99	43.1 (0.01)

[1] Birds / ha. [2] One-way ANOVA comparing species richness, density or total abundance across edge types.

Table 9. Mean (± SE) avian species richness and abundance along 300 meter line transects (50 meters fixed width) within four edge habitat types of the MTRVF sites in southwestern West Virginia. Data were compiled from spring migration counts from April 11 - May 31, 2000. Data from fall migration counts (from August 1 - September 10, 2000) showed similarity with spring, and, thus, are not shown.

Spring	Grassland (Distance from edge, m)			Shrub (Distance from edge, m)		
	0	150	300	0	150	300
Species	12.02 (0.84)	12.66 (0.95)	12.90 (0.87)	19.0 (1.20)	18.29 (1.25)	18.56 (1.13)
Density[1]	8.30 (0.60)	8.44 (0.45)	8.23 (0.52)	12.47 (0.78)	12.26 (0.84)	12.38 (0.85)
	Forest (fragment) (Distance from edge, m)			Forest (intact) (Distance from edge, m)		
	0	150	300	0	150	300
Species	9.04 (0.82)	9.10 (0.90)	9.19 (0.81)	7.30 (0.49)	7.25 (0.45)	7.17 (0.51)
Density[1]	6.66 (0.43)	6.63 (0.45)	6.55 (0.50)	5.24 (0.45)	5.20 (0.40)	5.02 (0.40)

[1] Birds / ha. Two-way ANOVA was used to test for treatment differences in species richness or density across edge types and by distance. Dependent variables differed across habitats ($p < 0.05$), but did not vary within groups by distance ($p > 0.05$).

Table 10. Bird species observed (mean with standard errors in parentheses) during 50-m radius point count surveys on MTRVF (this study = TS) edges in June - mid July 2000 and throughout contour mine sites in southern West Virginia (sWV) during the breeding season. N = 30 points in each edge type selected at random throughout sWV.

	Habitats[1]											
Species	G/F		G/FF		G/S		S/FF		ANOVA Results[2]			
	sWV	TS	sWV	TS	sWV	TS	sWV	TS	sWV F	sWV p	TS F	TS p
Forest Interior Species												
Acadian Flycatcher	0.22^{B} (0.03)	0.18^{B} (0.02)	0.15^{C} (0.02)	0.14^{B} (0.02)	0.03^{D} (0.007)	0.02^{C} (0.006)	0.23^{B} (0.03)	0.19^{B} (0.03)	27.41	0.001	17.91	0.001
Black-throated Green Warbler	$0.08^{C,D}$ (0.01)	0.04^{B} (0.009)	$0.06^{B,C}$ (0.01)	0.03^{B} (0.004)	0.04^{B} (0.008)	0.04^{B} (0.004)	0.11^{D} (0.02)	0.10^{C} (0.02)	4.75	0.004	8.68	0.001
Blue-headed Vireo	0.12^{B} (0.03)	0.03^{B} (0.005)	0.04^{C} (0.007)	0.03^{B} (0.008)	0.02^{C} (0.004)	0.01^{B} (0.003)	0.15^{B} (0.03)	0.06^{C} (0.009)	12.10	0.001	3.84	0.025
Cerulean Warbler	0.10^{B} (0.00)	0.04^{B} (0.00)	0.00^{C} (0.00)	0.00^{C} (0.00)	0.00^{C} (0.00)	0.00^{C} (0.00)	0.31^{D} (0.08)	0.23^{D} (0.05)	14.02	0.001	13.49	0.001
Eastern Wood-Pewee	0.25^{B} (0.09)	0.18^{B} (0.03)	0.08^{C} (0.02)	0.08^{C} (0.02)	0.00^{D} (0.00)	0.00^{D} (0.00)	0.30^{B} (0.10)	0.18^{B} (0.08)	10.14	0.001	8.00	0.001

Table 10. Continued.

Species	Habitats								ANOVA Results[a]		
	G/F		G/FF		G/S		S/FF			F	p
	sWV	TS	sWV	TS	sWV	TS	sWV	TS			
Great-crested Flycatcher	0.08^{B}	0.07^{B}	0.10^{B}	0.07^{B}	0.08^{B}	0.10^{C}	0.13^{C}	0.12^{C}	sWV	3.15	0.05
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.03)	TS	3.11	0.05
Kentucky Warbler	0.04	0.02	0.03	0.03	0.00	0.00	0.05	0.02	sWV	1.79	0.18
	(0.008)	(0.006)	(0.009)	(0.007)	(0.00)	(0.00)	(0.008)	(0.007)	TS	1.30	0.277
Louisiana Waterthrush	0.00^{B}	0.00^{B}	0.00^{B}	0.00^{B}	0.00^{B}	0.00^{B}	0.08^{C}	0.03^{C}	sWV	44.20	0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.006)	(0.007)	TS	14.95	0.001
Ovenbird	0.23^{B}	0.10^{B}	0.18^{B}	0.16^{C}	0.00^{C}	0.00^{D}	0.29^{D}	0.20^{C}	sWV	30.06	0.001
	(0.04)	(0.03)	(0.04)	(0.03)	(0.00)	(0.00)	(0.06)	(0.05)	TS	19.28	0.001
Pileated Woodpecker	0.08^{B}	0.05	0.06^{B}	0.03	0.02^{C}	0.03	0.10^{B}	0.05	sWV	7.33	0.001
	(0.003)	(0.004)	(0.003)	(0.005)	(0.004)	(0.006)	(0.02)	(0.007)	TS	2.10	0.16
Scarlet Tanager	0.28^{B}	0.20^{B}	$0.25^{B,C}$	$0.17^{B,C}$	0.05^{D}	0.09^{D}	0.22^{C}	0.22^{C}	sWV	33.91	0.001
	(0.07)	(0.05)	(0.06)	(0.03)	(0.006)	(0.01)	(0.06)	(0.05)	TS	20.83	0.001

Table 10. Continued.

Species	Habitats								ANOVA Results[a]	
	G/F		G/FF		G/S		S/FF		F	p
	sWV	TS	sWV	TS	sWV	TS	sWV	TS		
Summer Tanager	0.00^{B} (0.00)	0.03^{B} (0.006)	0.00^{B} (0.00)	0.05^{B} (0.007)	0.00^{B} (0.00)	0.00^{C} (0.00)	0.08^{C} (0.009)	0.10^{C} (0.02)	sWV 40.95 TS 31.64	 0.001 0.001
Swainson s Warbler	0.00^{B} (0.00)	0.00 (0.00)	0.00^{B} (0.00)	0.00 (0.00)	0.00^{B} (0.00)	0.00 (0.00)	0.04^{C} (0.006)	0.00 (0.00)	sWV 36.22	 0.001
Wood Thrush	0.32^{B} (0.07)	0.30^{B} (0.08)	0.29^{B} (0.08)	0.27^{B} (0.08)	0.00^{C} (0.00)	0.00^{C} (0.00)	0.30^{B} (0.06)	0.25^{B} (0.05)	sWV 50.88 TS 45.96	 0.001 0.001
Worm-eating Warbler	0.19^{B} (0.06)	0.13^{B} (0.04)	0.16^{B,C} (0.04)	0.10^{B,C} (0.01)	0.00^{D} (0.00)	0.00^{D} (0.00)	0.12^{C} (0.02)	0.08^{C} (0.02)	sWV 29.15 TS 25.33	 0.001 0.001
Yellow-throated Warbler	0.06^{B} (0.004)	0.08^{B} (0.005)	0.04^{B} (0.006)	0.06^{B} (0.003)	0.00^{C} (0.00)	0.00^{C} (0.00)	0.04^{B} (0.005)	0.05^{B} (0.007)	sWV 10.41 TS 14.93	 0.001 0.001
Interior-edge Species										
American Redstart	0.09^{B} (0.003)	0.11^{B} (0.02)	0.14^{C} (0.02)	0.14^{C} (0.03)	0.14^{B} (0.04)	0.15^{C} (0.03)	0.35^{D} (0.08)	0.26^{D} (0.06)	sWV 64.71 TS 42.17	 0.001 0.001

Table 10. Continued.

Species	Habitats								ANOVA Results[a]	
	G/F		G/FF		G/S		S/FF		F	p
	sWV	TS	sWV	TS	sWV	TS	sWV	TS		
American Robin	0.24[B] (0.06)	0.18[B] (0.05)	0.30[C] (0.09)	0.22[C] (0.07)	0.20[B] (0.04)	0.12[C] (0.02)	0.24[B] (0.05)	0.12[C] (0.03)	sWV 4.61 TS 9.88	0.005 0.001
Black-and-white Warbler	0.27[B] (0.08)	0.25[B] (0.05)	0.22[C] (0.03)	0.21[C] (0.04)	0.03[D] (0.005)	0.03[D] (0.007)	0.23[C] (0.05)	0.23[B,C] (0.06)	sWV 28.05 TS 25.91	0.001 0.001
Blue-gray Gnatcatcher	0.15[B] (0.04)	0.17[B] (0.05)	0.18[B] (0.05)	0.19[B] (0.06)	0.11[C] (0.02)	0.13[C] (0.02)	0.25[D] (0.06)	0.26[D] (0.08)	sWV 18.75 TS 16.39	0.001 0.001
Carolina Chickadee	0.10 (0.03)	0.11 (0.02)	0.08 (0.02)	0.10 (0.02)	0.08 (0.02)	0.10 (0.03)	0.11 (0.04)	0.11 (0.02)	sWV 1.33 TS 1.27	0.28 0.31
Carolina Wren	0.20[B] (0.05)	0.22[B] (0.04)	0.24[C] (0.07}	0.30[C] (0.05)	0.14[D] (0.04)	0.16[D] (0.05)	0.31[E] (0.07)	0.38[E] (0.08)	sWV 46.84 TS 67.05	0.001 0.001

Table 10. Continued.

Species	Habitats: G/F sWV	G/F TS	G/FF sWV	G/FF TS	G/S sWV	G/S TS	S/FF sWV	S/FF TS	ANOVA Results[a] F	p
Downy Woodpecker	0.11 (0.02)	$0.13^{C,D}$ (0.03)	0.11 (0.04)	0.10^{C} (0.02)	0.10 (0.03)	0.05^{B} (0.009)	0.13 (0.02)	0.15^{D} (0.04)	sWV 2.56 TS 3.95	 0.07 0.01
Eastern Phoebe	0.13 (0.02)	0.15 (0.04)	0.16 (0.02)	0.15 (0.02)	0.13 (0.02)	0.12 (0.04)	0.15 (0.02)	0.15 (0.03)	sWV 1.12 TS 0.91	 0.34 0.43
Eastern Towhee	0.21^{B} (0.04)	0.18^{B} (0.05)	0.17^{C} (0.02)	0.17^{B} (0.04)	0.24^{B} (0.04)	0.16^{B} (0.04)	0.33^{D} (0.08)	0.22^{C} (0.02)	sWV 16.02 TS 13.89	 0.001 0.001
Hairy Woodpecker	0.05 (0.006)	0.04^{B} (0.005)	0.05 (0.007)	0.07^{B} (0.005)	0.03 (0.007)	0.02^{C} (0.004)	0.05 (0.004)	0.07^{B} (0.003)	sWV 0.79 TS 3.40	 0.48 0.047
Hooded Warbler	0.28^{B} (0.07)	0.23^{B} (0.05)	0.23^{C} (0.03)	0.20^{B} (0.04)	0.00^{D} (0.00)	0.00^{C} (0.00)	0.32^{E} (0.08)	0.30^{D} (0.07)	sWV 22.71 TS 31.96	 0.001 0.001
Northern Flicker	$0.12^{B,C}$ (0.02)	$0.14^{B,C}$ (0.03)	$0.14^{C,D}$ (0.04)	0.16^{C} (0.03)	0.10^{B} (0.02)	0.11^{B} (0.02)	0.18^{D} (0.05)	0.20^{D} (0.04)	sWV 15.10 TS 19.23	 0.001 0.001

Table 10. Continued.

Species	Habitats								ANOVA Results[a]	
	G/F		G/FF		G/S		S/FF		F	p
	sWV	TS	sWV	TS	sWV	TS	sWV	TS		
Northern Parula	0.16[B] (0.02)	0.10[B] (0.01)	0.10[C] (0.02)	0.10[C] (0.02)	0.02[D] (0.006)	0.00[C] (0.00)	0.14[B] (0.03)	0.11[B] (0.02)	sWV 8.97 TS 7.85	0.001 0.001
Red-bellied Woodpecker	0.06[B] (0.007)	0.09[B] (0.003)	0.10[C] (0.02)	0.09[B] (0.004)	0.03[B] (0.005)	0.03[C] (0.004)	0.12[C] (0.03)	0.13[D] (0.02)	sWV 20.93 TS 18.41	0.001 0.001
Red-eyed Vireo	0.78[B] (0.04)	0.71[B] (0.06)	0.73[C] (0.05)	0.67[C] (0.05)	0.62[D] (0.04)	0.60[C] (0.05)	1.25[E] (0.04)	1.05[E] (0.08)	sWV 67.96 TS 60.08	0.001 0.001
Ruby-throated Hummingbird	0.18[B] (0.04)	0.20[B] (0.02)	0.22[C] (0.05)	0.20[B] (0.04)	0.22[C] (0.05)	0.23[C] (0.03)	0.25[C,D] (0.06)	0.27[C] (0.05)	sWV 18.17 TS 14.59	0.001 0.001
Tufted Titmouse	0.24[B,C] (0.04)	0.20[B,C] (0.02)	0.20[B] (0.02)	0.18[B] (0.02)	0.13[D] (0.01)	0.10[D] (0.008)	0.26[C] (0.04)	0.24[C] (0.03)	sWV 38.61 TS 47.22	0.001 0.001
White-breasted Nuthatch	0.08[B] (0.006)	0.10[B] (0.009)	0.04[C] (0.005)	0.06[C] (0.005)	0.02[D] (0.003)	0.02[D] (0.005)	0.06[B,C] (0.008)	0.08[B,C] (0.02)	sWV 10.35 TS 15.69	0.001 0.001

Table 10. Continued.

Species	Habitats G/F sWV	G/F TS	G/FF sWV	G/FF TS	G/S sWV	G/S TS	S/FF sWV	S/FF TS	ANOVA Results[a] F	p
Yellow-billed Cuckoo	0.13[B,C] (0.04)	0.10[B] (0.02)	0.10[B] (0.008)	0.13[B,C] (0.02)	0.16[C] (0.04)	0.16[C] (0.03)	0.27[D] (0.05)	0.25[D] (0.04)	sWV 3.37 TS 4.08	0.05 0.01
Yellow-throated Vireo	0.15[B] (0.07)	0.19[B] (0.07)	0.12[B] (0.05)	0.22[B,C] (0.08)	0.05[C] (0.008)	0.07[D] (0.01)	0.26[D] (0.07)	0.24[C] (0.08)	sWV 17.04 TS 13.67	0.001 0.001
Edge Species										
American Crow	0.13 (0.05)	0.08 (0.03)	0.16 (0.07)	0.10 (0.04)	0.13 (0.05)	0.07 (0.01)	0.15 (0.06)	0.10 (0.05)	sWV 2.03 TS 1.96	0.16 0.17
American Goldfinch	0.16 (0.06)	0.12 (0.04)	0.17 (0.08)	0.12 (0.06)	0.18 (0.06)	0.15 (0.07)	0.18 (0.07)	0.14 (0.05)	sWV 0.83 TS 0.97	0.47 0.387
Baltimore Oriole	0.06 (0.03)	0.08 (0.04)	0.04 (0.008)	0.07 (0.01)	0.04 (0.01)	0.06 (0.02)	0.06 (0.02)	0.08 (0.02)	sWV 0.77 TS 0.81	0.50 0.48
Blue Grosbeak	0.00 (0.00)	0.00[B] (0.00)	0.00 (0.00)	0.00[B] (0.00)	0.00 (0.00)	0.08[C] (0.04)	0.00 (0.00)	0.17[D] (0.08)	TS 40.51	0.001

Table 10. Continued.

Species	Habitats: G/F sWV	G/F TS	G/FF sWV	G/FF TS	G/S sWV	G/S TS	S/FF sWV	S/FF TS	ANOVA Results[a] sWV F	sWV p	TS F	TS p
Blue Jay	0.14 (0.08)	0.18 (0.07)	0.16 (0.08)	0.18 (0.06)	0.13 (0.05)	0.15 (0.07)	0.16 (0.07)	0.18 (0.08)	2.05	0.16	0.82	0.48
Blue-winged Warbler	0.14^{B} (0.06)	0.10^{B} (0.06)	0.10^{B} (0.05)	0.12^{B} (0.06)	0.38^{C} (0.07)	0.50^{C} (0.06)	1.22^{D} (0.06)	1.02^{D} (0.07)	70.09	0.001	67.34	0.001
Brown Thrasher	0.05^{B} (0.01)	0.04^{B} (0.009)	0.08^{B} (0.04)	0.06^{B} (0.02)	0.17^{C} (0.10)	0.20^{C} (0.09)	0.15^{C} (0.07)	0.20^{C} (0.08)	35.91	0.001	43.82	0.001
Brown-headed Cowbird	0.10^{B} (0.03)	0.03^{B} (0.005)	0.13^{B} (0.04)	0.05^{B} (0.02)	0.17^{C} (0.08)	0.12^{C} (0.06)	0.10^{B} (0.05)	0.05^{B} (0.01)	23.85	0.001	17.54	0.001
Cedar Waxwing	0.07^{B} (0.02)	0.04^{B} (0.02)	0.07^{B} (0.03)	0.07^{C} (0.03)	0.06^{B} (0.02)	0.04^{B} (0.007)	0.10^{C} (0.04)	0.12^{D} (0.05)	3.36	0.05	3.73	0.018
Chipping Sparrow	0.10^{B} (0.04)	0.08^{B} (0.02)	0.15^{C} (0.06)	0.12^{B} (0.06)	0.20^{D} (0.07)	0.23^{C} (0.08)	0.22^{D} (0.07)	0.27^{D} (0.08)	53.48	0.001	63.10	0.001

Table 10. Continued.

Species	Habitats								ANOVA Results[a]	
	G/F		G/FF		G/S		S/FF		F	p
	sWV	TS	sWV	TS	sWV	TS	sWV	TS		
Common Yellowthroat	0.18[B] (0.06)	0.22[B] (0.09)	0.20[B] (0.08)	0.25[B] (0.10)	0.82[C] (0.07)	0.85[C] (0.05)	0.57[D] (0.05)	0.64[D] (0.03)	sWV 59.85 TS 64.04	 0.001 0.001
Eastern Bluebird	0.13 (0.04)	0.16 (0.05)	0.18 (0.03)	0.20 (0.03)	0.16 (0.04)	0.15 (0.04)	0.10 (0.02)	0.13 (0.02)	sWV 1.30 TS 0.66	 0.277 0.541
Field Sparrow	0.26[B] (0.05)	0.28[B] (0.05)	0.38[B] (0.05)	0.45[C] (0.15)	1.21[C] (0.07)	1.07[D] (0.08)	0.50[D] (0.04)	0.66[E] (0.07)	sWV 86.56 TS 79.10	 0.001 0.001
Golden-winged Warbler	0.11[B] (0.02)	0.02[B] (0.007)	0.13[B] (0.02)	0.04[B] (0.009)	0.10[B] (0.02)	0.02[B] (0.007)	0.42[C] (0.05)	0.36[C] (0.04)	sWV 42.19 TS 100.79	 0.001 0.001
Gray Catbird	0.07[B] (0.03)	0.02[B] (0.007)	0.10[B,C] (0.02)	0.05[B] (0.009)	0.16[C] (0.03)	0.11[C] (0.04)	0.38[D] (0.05)	0.31[D] (0.05)	sWV 34.39 TS 45.49	 0.001 0.001
Indigo Bunting	0.50[B] (0.07)	0.54[B] (0.08)	0.48[B] (0.08)	0.57[B,C] (0.10)	0.88[C] (0.10)	0.65[C] (0.11)	1.50[D] (0.11)	1.20[D] (0.12)	sWV 108.63 TS 90.44	 0.001 0.001

Table 10. Continued.

	Habitats									
Species	G/F		G/FF		G/S		S/FF		ANOVA Results[a] F	p
	sWV	TS	sWV	TS	sWV	TS	sWV	TS		
Mourning Dove	0.05	0.07	0.07	0.08	0.05	0.09	0.07	0.10	sWV	
	(0.007)	(0.02)	(0.02)	(0.02)	(0.009)	(0.02)	(0.02)	(0.04)	1.77	0.18
									TS	
									1.28	0.28
Northern Bobwhite	0.03	0.03	0.03	0.04	0.04	0.04	0.03	0.03	sWV	
	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.009)	1.65	0.20
									TS	
									1.10	0.31
Northern Cardinal	0.11^{B}	0.15^{B}	0.15^{B}	0.17^{B}	0.09^{B}	0.10^{B}	0.61^{C}	0.55^{C}	sWV	
	(0.03)	(0.04)	(0.02)	(0.06)	(0.02)	(0.04)	(0.07)	(0.06)	67.06	0.001
									TS	
									59.28	0.001
Orchard Oriole	0.09^{B}	0.11^{B}	$0.05^{B,C}$	0.05^{C}	0.02^{C}	0.03^{C}	0.06^{B}	0.06^{C}	sWV	
	(0.03)	(0.02)	(0.01)	(0.01)	(0.007)	(0.007)	(0.01)	(0.02)	4.64	0.004
									TS	
									6.37	0.001
Prairie Warbler	0.05^{B}	0.07^{B}	0.04^{B}	0.07^{B}	0.27^{C}	0.35^{C}	0.55^{D}	1.09^{D}	sWV	
	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)	(0.05)	(0.05)	(0.04)	114.75	0.001
									TS	
									138.75	0.001
Song Sparrow	0.17^{B}	0.14^{B}	0.25^{C}	0.20^{C}	0.32^{D}	0.28^{D}	$0.21^{B,C}$	0.14^{B}	sWV	
	(0.03)	(0.03)	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)	(0.02)	5.63	0.001
									TS	
									4.21	0.037

Table 10. Continued.

Species	Habitats								ANOVA Results[a]	
	G/F		G/FF		G/S		S/FF		F	p
	sWV	TS	sWV	TS	sWV	TS	sWV	TS		
White-eyed Vireo	0.05^{B} (0.01)	0.08^{B} (0.02)	0.05^{B} (0.01)	0.10^{B} (0.02)	0.27^{C} (0.04)	0.33^{C} (0.05)	0.24^{C} (0.03)	0.27^{C} (0.04)	sWV 42.35 TS 26.81	 0.001 0.001
Willow Flycatcher	0.00^{B} (0.00)	0.00^{B} (0.00)	0.00^{B} (0.00)	0.00^{B} (0.00)	0.20^{C} (0.03)	0.12^{C} (0.02)	0.11^{D} (0.02)	0.10^{C} (0.02)	sWV 43.54 TS 21.48	 0.001 0.001
Yellow Warbler	0.06^{B} (0.02)	0.10^{B} (0.03)	0.10^{B} (0.03)	0.11^{B} (0.02)	0.24^{C} (0.04)	0.31^{C} (0.04)	0.06^{B} (0.01)	0.07^{B} (0.01)	sWV 22.64 TS 29.35	 0.001 0.001
Yellow-breasted Chat	0.18^{B} (0.04)	0.15^{B} (0.05)	0.21^{B} (0.05)	0.20^{B} (0.03)	0.20^{B} (0.03)	0.20^{B} (0.04)	1.27^{C} (0.05)	1.00^{C} (0.05)	SWV 238.08 TS 200.65	 0.001 0.001
Grassland Species										
Bobolink	0.00^{B} (0.00)	0.00^{B} (0.00)	0.04^{C} (0.01)	0.03^{C} (0.008)	0.05^{C} (0.01)	0.03^{C} (0.007)	0.00^{B} (0.00)	0.00^{B} (0.00)	sWV 9.23 TS 8.75	 0.001 0.001
Dickcissel	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.03 (0.002)	0.00 (0.00)	0.03 (0.002)	0.00 (0.00)	0.00 (0.00)	TS 2.15	 0.14

Table 10. Continued.

Species	Habitats: G/F sWV	G/F TS	G/FF sWV	G/FF TS	G/S sWV	G/S TS	S/FF sWV	S/FF TS	ANOVA Results[a] F	ANOVA Results[a] p
Eastern Meadowlark	0.32[B] (0.04)	0.40[B] (0.05)	0.36[B,C] (0.04)	0.71[C] (0.04)	0.42[C] (0.04)	0.76[C] (0.05)	0.00[D] (0.00)	0.00[D] (0.00)	sWV 43.98 TS 120.59	 0.001 0.001
Grasshopper Sparrow	0.30[B] (0.03)	0.38[B] (0.04)	0.37[B] (0.04)	0.48[B] (0.04)	0.53[C] (0.05)	1.81[C] (0.07)	0.11[D] (0.02)	0.26[D] (0.04)	sWV 29.92 TS 348.62	 0.001 0.001
Horned Lark	0.11[B] (0.02)	0.19[B] (0.03)	0.16[C] (0.03)	0.23[C] (0.03)	0.19[C] (0.02)	0.29[C] (0.04)	0.00[D] (0.00)	0.00[D] (0.00)	sWV 25.12 TS 35.89	 0.001 0.001
Red-winged Blackbird	0.22[B] (0.02)	0.22[B,C] (0.05)	0.24[B] (0.04)	0.26[C] (0.04)	0.85[D] (0.07)	0.90[D] (0.07)	0.15[D] (0.03)	0.19[B] (0.05)	sWV 165.97 TS 189.73	 0.001 0.001
Vesper Sparrow	0.08[B] (0.02)	0.05[B] (0.03)	0.07[C] (0.01)	0.05[C] (0.01)	0.05[B] (0.02)	0.08[B] (0.02)	0.00[C] (0.00)	0.00[C] (0.00)	sWV 4.45 TS 4.29	 0.005 0.038

Table 10. Continued.

Other Species	G/F sWV	G/F TS	G/FF sWV	G/FF TS	G/S sWV	G/S TS	S/FF sWV	S/FF TS	ANOVA Results[a] F	ANOVA Results[a] p
American Kestrel	0.09[B] (0.03)	0.10[B] (0.02)	0.12[B,C] (0.03)	0.16[C] (0.03)	0.15[C] (0.03)	0.17[C] (0.04)	0.03[D] (0.008)	0.01[D] (0.004)	sWV 9.38 TS 20.59	0.001 0.001
Bank Swallow	0.07[B,C] (0.02)	0.06 (0.01)	0.10[C] (0.03)	0.09 (0.02)	0.11[C] (0.03)	0.08 (0.02)	0.03[B] (0.009)	0.04 (0.01)	sWV 3.91 TS 1.18	0.011 0.321
Barn Swallow	0.10[B,C] (0.03)	0.06 (0.01)	0.14[C,D] (0.02)	0.08 (0.02)	0.15[D] (0.03)	0.09 (0.02)	0.08[B] (0.02)	0.05 (0.01)	sWV 3.97 TS 1.02	0.01 0.387
Chimney Swift	0.23 (0.04)	0.27[C] (0.02)	0.26 (0.05)	0.32[C] (0.03)	0.22 (0.03)	0.26[B,C] (0.02)	0.19 (0.03)	0.20[B] (0.03)	sWV 1.43 TS 4.42	0.238 0.005
Killdeer	0.04[B] (0.01)	0.07[B] (0.01)	0.07[B,C] (0.0)	0.10[B,C] (0.0	0.09[C] (0.02)	0.13[C] (0.03)	0.0[D] (0.00)	0.00[D] (0.00)	sWV 7.62 TS 16.79	0.001 0.001
Mallard	0.11[B] (0.03)	0.20[B] (0.03)	0.13[B] (0.01)	0.20[B] (0.02)	0.14[B] (0.03)	0.22[B] (0.02)	0.00[C] (0.00)	0.00[C] (0.00)	sWV 34.12 TS 50.27	0.001 0.001

Table 10. Continued.

Species	Habitats: G/F sWV	G/F TS	G/FF sWV	G/FF TS	G/S sWV	G/S TS	S/FF sWV	S/FF TS	ANOVA Results[a] F	p
Tree Swallow	0.25^{B} (0.02)	0.20^{B} (0.02)	$0.30^{B,C}$ (0.03)	0.32^{C} (0.02)	0.32^{C} (0.04)	0.38^{C} (0.03)	0.09^{D} (0.01)	0.08^{D} (0.01)	sWV 26.06 TS 51.68	 0.001 0.001
Turkey Vulture	0.04 (0.009)	0.03^{B} (0.008)	0.08 (0.02)	$0.06^{C,D}$ (0.02)	0.06 (0.009)	0.08^{D} (0.01)	0.04 (0.009)	$0.05^{B,C}$ (0.009)	sWV 2.59 TS 4.46	 0.07 0.005

[1] G/F = grassland/forest (intact) ecotone, G/FF = grassland/forest fragment or island ecotone, G/S = grassland/shrub ecotone, and S/FF = Shrub/forest fragment ecotone. The S/FF ecotone is generally the result of roads and contour mines that are approximately 30 years in secondary succession, and, thus, is young forest bordered by mature forest. Most of these latter forests are quite large and fragmented by mainly roads and a few scattered houses (see Canterbury et al 1996). [2] One-way ANOVA was used to test for mean abundance differences across habitat types. Results from sWV and this study (TS) were tested separately. Means with different letters are significantly different (Duncan s multiple comparisons test). The reader should compare means within each study (either SWV or TS) and not across studies.

Table 11. Importance values (IV) of selected bird species in summer on MTRVFs.

Species	IV	Species	IV
High Occurence		**Low Occurence**	
Red-eyed Vireo	200	Northern Cardinal	49
Indigo Bunting	193	Ruby-thr. Hummingbird	42
Grasshopper Sparrow	190	Wood Thrush	35
Field Sparrow	170	Song Sparrow	32
Common Yellowthroat	150	Blue-gray Gnatcatcher	30
Eastern Meadowlark	127	White-eyed Vireo	30
Moderate Occurence		N. Rough-winged Swallow	25
Blue-winged Warbler	115	Eastern Towhee	24
Red-winged Blackbird	100	Hooded Warbler	24
Prairie Warbler	99	Black-and-White Warbler	20
Yellow-breasted Chat	90	Tufted Titmouse	20
Carolina Wren	63	Yellow-throated Vireo	19
Chimney Swift	60	Horned Lark	15
Tree Swallow	53	Carolina Chickadee	10

Table 12. Number of birds (total and mean) banded during five fall migration seasons (1996-2000) in southern West Virginia at Three Rivers Migration Observatory (TRMO) and percent (%) of total that were captured on a contour mine (10% of the TRMO observatory area) in Raleigh County, West Virginia.

Species	Total	Mean	%
Grassland			
Common Grackle	13	2.6	0%
Eastern Bluebird	17	3.4	58.8%
Eastern Kingbird	1	0.2	0%
Eastern Meadowlark	1	0.2	100%
European Starling	1	0.2	0%
Grasshopper Sparrow	15	3.0	100%
Horned Lark	1	0.2	100%
Mourning Dove	40	8.0	0%
Red-winged Blackbird	6	1.2	33.3%
Savannah Sparrow	1	0.2	100%
Shrubland			
American Goldfinch	1842	368.4	20%
American Redstart	203	40.6	7.9%
American Robin	48	9.6	6.2%
Baltimore Oriole	6	1.2	0%
Bay-breasted Warbler	71	14.2	31%
Black-billed Cuckoo	2	0.4	0%
Blackpoll Warbler	24	4.8	3%
Blue Grosbeak	2	0.4	100%
Blue-winged Warbler	22	4.4	31.8%
Brown Thrasher	41	8.2	24.4%
Carolina Wren	128	25.6	27.3%

Table 12. Continued.

Species	Total	Mean	%
Cedar Waxwing	75	15.0	14.7%
Chestnut-sided Warbler	80	16.0	40%
Chipping Sparrow	178	35.6	42.1%
Common Yellowthroat	322	64.4	31.1%
Dark-eyed Junco	182	36.4	2.7%
Eastern Phoebe	74	14.8	18.9%
Eastern Towhee	150	30.0	22%
Field Sparrow	191	38.2	31.9%
Golden-winged Warbler	22	4.4	36.4%
Gray Catbird	467	93.4	19.3%
Great-crested Flycatcher	2	0.4	0%
Hairy Woodpecker	3	0.6	33.3%
House Finch	1695	339.0	0.6%
House Wren	81	16.2	14.8
Indigo Bunting	520	104.0	36.5%
Kentucky Warbler	22	4.4	18.2%
Least Flycatcher	18	3.6	22.2%
Lincoln s Sparrow	87	17.4	37.9%
Magnolia Warbler	405	81.0	5.7%
Mourning Warbler	14	2.8	0%
Nashville Warbler	46	9.2	30.4%
Northern Cardinal	266	53.2	18.4%
Northern Flicker	2	0.4	0%
Northern Mockingbird	12	2.4	0%
Northern Waterthrush	26	5.2	23.1%

Table 12. Continued.

Species	Total	Mean	%
Orange-crowned Warbler	2	0.4	0%
Palm Warbler	96	19.2	27.1%
Pine Siskin	711	142.2	0%
Pine Warbler	6	1.2	0%
Prairie Warbler	19	3.8	26.3%
Purple Finch	14	2.8	0%
Red-bellied Woodpecker	9	1.8	11.1%
Ruby-throated Hummingbird	557	111.4	20%
Scarlet Tanager	62	12.4	12.9%
Song Sparrow	695	139.0	14.8%
Swamp Sparrow	195	39.0	11.8%
Tennessee Warbler	1131	226.2	22.1%
Traill s Flycatcher	38	7.6	13.2%
White-crowned Sparrow	18	3.6	27.8%
White-eyed Vireo	40	8.0	37.5%
White-throated Sparrow	440	88.0	15.7%
Worm-eating Warbler	48	9.6	37.5%
Yellow-breasted Chat	9	1.8	22.2%
Yellow-billed Cuckoo	7	1.4	28.6%
Yellow-rumped Warbler	338	67.6	10.4%
Yellow Warbler	20	4.0	0%
Forest			
Acadian Flycatcher	18	3.6	0%
Belted Kingfisher	1	0.2	0%
Black-and-White Warbler	45	9.0	20%
Blackburnian Warbler	22	4.4	0%

Table 12. Continued.

Species	Total	Mean	%
Black-throated Blue Warbler	59	11.8	30.5%
Black-throated Green Warbler	84	16.8	31%
Blue-gray Gnatcatcher	80	16.0	15%
Blue Jay	106	21.2	17%
Blue-headed Vireo	69	13.8	42%
Cape May Warbler	18	3.6	22.2%
Carolina Chickadee	178	35.6	22.5%
Cerulean Warbler	1	0.2	0%
Downy Woodpecker	42	8.4	26.2%
Eastern Screech-Owl	2	0.4	0%
Golden-crowned Kinglet	42	8.4	11.9%
Hermit Thrush	29	5.8	34.5%
Hooded Warbler	107	21.4	34.6%
Louisiana Waterthush	10	2.0	0%
Northern Parula	22	4.4	9.1%
Orchard Oriole	1	0.2	0%
Ovenbird	120	24.0	25.8%
Philadelphia Vireo	2	0.4	0%
Red-eyed Vireo	139	27.8	23%
Rose-breasted Grosbeak	28	5.6	0%
Ruby-crowned Kinglet	171	34.2	16.4%
Sharp-shinned Hawk	5	1.0	0%
Swainson s Thrush	144	28.8	22.2%
Tufted Titmouse	209	41.8	35%
White-breasted Nuthatch	27	5.4	0%

Table 12. Continued.

Species	Total	Mean	%
Winter Wren	38	7.6	18.4%
Wood Thrush	26	5.2	26.9%
Yellow-throated Vireo	22	4.4	27.3%
Yellow-throated Warbler	10	2.0	20%

Birds were classified into habitat categories based on primary place of capture.

Table 13. Mean number of detections per foraging guild during winter and breeding seasons on edge plots (N = 38) of MTRVF sites in southwestern West Virginia. Data analyzed for 38 randomly selected point counts of the 134 plots due to time constraints.

	G/F	G/FF	G/S	S/FF	G/F	G/FF	G/S	S/FF
	Winter				**Breeding**			
Foraging Guild								
Ground-shrub	6	6	8	10	9	12	15	13
Trunk-bark	3	3	2	5	6	4	4	8
Sallier-canopy	6	4	4	8	11	10	7	14

G/F = grassland/forest (intact), G/FF = grassland/forest fragment, G/S = grassland / shrub (pole), and S/FF = shrub (pole) / forest (fragment). Data were normally distributed (Shapiro-Wilks test, $p > 0.13$).

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Table 14. Relationship between edge length and number of species and individuals (singing males/point) in major trophic groups.

Trophic group	Slope	Intercept	R	p
Species richness				
Omnivores	0.73	0.4	0.88	0.001
Bark Insectivores	0.40	0.9	0.79	0.01
Ground Insectivores	0.63	0.6	0.92	0.001
Foliage Insectivores	0.22	1.2	0.64	0.05
Aerial Insectivores	0.69	0.3	0.93	0.001
Abundance				
Omnivores	0.85	0.6	0.80	0.01
Bark Insectivores	-0.30	5.0	-0.58	0.05
Ground Insectivores	-0.19	2.2	0.75	0.02
Foliage Insectivores	0.25	1.9	-0.60	0.05
Aerial Insectivores	0.61	0.8	0.69	0.05

Table 15. Pearson product-moment correlations (r) among variables measured on three MTRFV sites in southwestern West Virginia.

	Percent Slope	Aspect	Elevation (meters)	Seral Stage	Edge Length (meters)
Species Richness	-0.371	-0.325	-0.386	-0.108	0.951*
Percent Slope		0.993**	-0.275	0.925*	-0.164
Aspect			-0.383	0.888	-0.093
Elevation (m)				-0.129	-0.647
Seral Stage[a]					0.015

[a] Young reclaimed grassland (3-22 years), shrub/pole succession (12-30 years), and forested land (35 years). * $p < 0.05$, ** $p < 0.01$.

Table 16. Pearson product-moment correlations among species diversity and vegetation components measured at shrub or pole/ forest fragment edge study plots in MTRVFs of southwestern West Virginia.

	Species Richness	Live Tree	Tall shrub	Short shrub	Dead tree	Tree height	Tree DBH
Species Richness		-0.235	-0.018	0.007	0.374	-0.145	0.074
Live Tree	-0.235		0.869**	0.799**	-0.703**	-0.778**	-0.897**
Tall shrub	-0.018	0.869**		0.983**	-0.721**	-0.971**	-0.887**
Short shrub	0.007	0.799**	0.983**		-0.871**	-0.957**	-0.871**
Dead tree	0.374	-0.703**	-0.721**	-0.640*		0.540*	0.710**
Tree height	-0.145	-0.778**	0.917**	-0.957**	0.540*		0.921**
Tree DBH	0.074	0.003	-0.887**	-0.871**	0.710**	0.921**	

Abbreviations for each vegetation category are defined in the text. * $p < 0.05$, ** $p < 0.01$.

Table 17. Percent slope and vegetation components (mean ± 1 SE) at edge and interior plots at 12 historical contour and seven historical MTRVF mines in southern West Virginia[a]. Comparisons were made using factorial ANOVA. Data were normally distributed (Levene statistic, $p > 0.05$). NS = no significant difference.

	Contour		MTRVFs		
Variable	Interior	Edge	Interior	Edge	$p < 0.05$
% Slope	38.7 ± 6.4	41.6 ± 7.5	33.8 ± 6.1	37.5 ± 7.0	NS
Tree Height (m)	22.9 ± 2.5	18.5 ± 2.1	20.3 ± 2.5	17.9 ± 1.8	NS
Litter Depth (cm)	4.0 ± 1.4	3.4 ± 1.1	3.8 ± 1.1	3.5 ± 0.9	NS
Percent Ground Cover	40.5 ± 2.2	37.9 ± 1.7	39.2 ± 2.0	35.6 ± 1.5	NS
Percent Canopy Cover	48.1 ± 2.3	39.0 ± 2.3	41.2 ± 2.4	36.5 ± 2.7	NS
Shrub Height (cm)	34.5 ± 6.0	40.7 ± 7.5	32.8 ± 6.6	37.0 ± 7.0	yes
Stem density / ha[b]	3.9 ± 0.05	3.2 ± 0.08	3.6 ± 0.06	3.0 ± 0.05	NS
Basal area[c]	112.5 ± 13.1	100.3 ± 10.6	104.7 ± 12.6	90.2 ± 10.9	yes

[a] All data were collected in July - August at the end of the growing season. A clinometer was used to measure tree height and slope; all other measures followed James and Shugart (1970). [b] log-transformed values. [c] We used a 10-factor prism to estimate basal area at 0.032 ha. vegetation plots within the study areas (Hovind and Rieck 1970).

Table 18. Population trends (percent annual change) of breeding birds of sWV coalfields (n = 32 historical sites). Data collected from 1989-2000. Methods follow from Geissler and Sauer (1990) and the BBS.

Species	Migratory Status[1]	Status & Abundance (birds per route)[2]	Distribution (out of 32 routes)	Trend (% annual change) ± SE	p
Great Blue Heron	Temperate migrant	FC (2.4)	25	8.4 (± 3.8)	0.01
Green Heron	Central neotropical migrant	R (0.81)	23	- 2.6 (± 1.7)	0.12
Wood Duck	Temperate migrant	R (0.43)	23	- 2.0 (± 1.3)	0.15
Mallard	Temperate migrant	C (4.0)	27	- 0.9 (± 0.06)	0.68
Canada Goose	Permanent resident	FC (3.1)	20	11.6 (± 1.9)	0.001
Turkey Vulture	Temperate migrant	FC (2.7)	32	4.4 (± 1.8)	0.03
Cooper s Hawk	Permanent resident Temperate migrant	R (0.85)	26	6.3 (± 2.0)	0.02
Sharp-shinned Hawk	Temperate and central neotropical migrant	R (0.05)	19	2.4 (± 1.7)	0.12
Red-tailed Hawk	Permanent resident Temperate migrant	R (0.61)	27	2.8 (± 0.9)	0.09
Red-shouldered Hawk	Temperate migrant	R (0.12)	20	- 3.4 (± 2.0)	0.04

Table 18. Continued.

Broad-winged Hawk	Southern neotropical migrant	R (0.10)	18	- 10.8 (± 2.4)	0.001
American Kestrel	Permanent resident Temperate migrant	R (0.05)	14	- 5.1 (± 1.1)	0.02
Killdeer	Temperate migrant	U (1.3)	15	- 4.7 (± 1.2)	0.03
Mourning Dove	Permanent resident	A (15.6)	32	14.4 (± 1.6)	0.001
Black-billed Cuckoo	Southern neotropical migrant	C (4.9)	32	- 3.3 (± 0.8)	0.04
Yellow-billed Cuckoo	Southern neotropical migrant	FC (2.6)	25	- 5.9 (± 1.2)	0.02
Chimney Swift	Southern neotropical migrant	FC (2.9)	23	2.5 (± 1.1)	0.16
Ruby-throated Hummingbird	Central neotropical migrant	FC (3.3)	32	6.1 (± 0.8)	0.02
Belted Kingfisher	Temperate migrant	U (1.4)	29	0.8 (± 0.9)	0.72
Red-headed Woodpecker	Temperate migrant	R (0.75)	14	- 15.4 (± 2.8)	0.001
Red-bellied Woodpecker	Permanent resident	C (5.6)	30	8.0 (± 1.3)	0.015
Downy Woodpecker	Permanent resident	C (4.1)	24	2.9 (± 0.7)	0.10
Hairy Woodpecker	Permanent resident	U (1.2)	18	1.5 (± 0.9)	0.23
Northern Flicker	Temperate migrant	C (5.6)	29	- 6.5 (± 1.4)	0.02

Table 18. Continued.

Pileated Woodpecker	Permanent resident	R (0.73)	22	4.8 (± 1.5)	0.035
Eastern Wood-Pewee	Southern neotropical migrant	C (6.7)	32	1.9 (± 0.8)	0.18
Acadian Flycatcher	Southern neotropical migrant	FC (3.5)	29	3.5 (± 1.0)	0.04
Willow Flycatcher	Central and southern neotropical migrant	FC (2.0)	29	- 5.0 (± 1.2)	0.02
Least Flycatcher	Central neotropical migrant	R (0.16)	14	- 7.9 (± 1.0)	0.01
Eastern Phoebe	Temperate migrant	FC (2.0)	30	- 5.8 (± 1.3)	0.02
Great-crested Flycatcher	Central neotropical migrant	FC (2.5)	32	1.5 (± 0.7)	0.20
Eastern Kingbird	Southern neotropical migrant	U (1.1)	20	- 0.9 (± 0.9)	0.65
Horned Lark	Permanent resident Temperate migrant	U (1.7)	15	- 8.0 (± 1.2)	0.01
Tree Swallow	Temperate migrant	R (0.5)	28	1.2 (± 0.9)	0.24
Northern Rough-Winged Swallow	Southern neotropical migrant	U (1.8)	27	4.8 (± 1.5)	0.03
Bank Swallow	Southern neotropical migrant	U (1.3)	22	1.6 (± 2.0)	0.20

Table 18. Continued.

Barn Swallow	Southern neotropical migrant	C (10.2)	30	- 6.5 (± 1.8)	0.02
Blue Jay	Permanent resident Temperate resident	A (13.0)	32	0.8 (± 0.5)	0.72
American Crow	Permanent resident Temperate resident	A (25.3)	32	17.0 (± 1.9)	0.001
Carolina Chickadee	Permanent resident	FC (3.9)	32	- 1.4 (± 0.9)	0.22
Tufted Titmouse	Permanent resident	A (14.1)	32	7.2 (± 2.0)	0.01
White-breasted Nuthatch	Permanent resident	FC (2.8)	31	3.5 (± 1.0)	0.04
Carolina Wren	Permanent resident	C (10.7)	32	1.7 (± 0.8)	0.19
House Wren	Temperate migrant	C (4.0)	18	5.9 (± 2.4)	0.02
Blue-gray Gnatcatcher	Central neotropical migrant	C (4.5)	26	3.9 (± 0.7)	0.04
Eastern Bluebird	Permanent resident Temperate migrant	C (4.2)	30	2.2 (± 0.9)	0.09
Wood Thrush	Central neotropical migrant	A (17.5)	32	3.0 (± 0.5)	0.047
American Robin	Permanent resident Temperate migrant	A (14.6)	32	4.1 (± 0.9)	0.03
Gray Catbird	Central neotropical migrant	C (9.0)	32	5.0 (± 1.1)	0.02

Table 18. Continued.

Brown Thrasher	Temperate migrant	C (6.6)	32	- 3.7 (± 0.8)	0.04
Cedar Waxwing	Temperate migrant	FC (3.1)	30	0.4 (± 0.7)	0.83
White-eyed Vireo	Central neotropical migrant	C (10.4)	29	- 7.0 (± 1.3)	0.01
Blue-headed Vireo	Central neotropical migrant	FC (2.5)	15	1.1 (± 0.4)	0.24
Yellow-throated Vireo	Central neotropical migrant	FC (3.7)	32	1.5 (± 0.5)	0.20
Red-eyed Vireo	Southern neotropical migrant	A (27.9)	32	6.5 (± 0.9)	0.02
Blue-winged Warbler	Central neotropical migrant	C (9.2)	23	7.2 (± 0.6)	0.01
Golden-winged Warbler	Central and southern neotropical migrant	A (17.0)	29	- 0.25 (± 0.2)	0.90
Northern Parula	Central neotropical migrant	FC (3.3)	20	0.35 (± 0.1)	0.81
Yellow Warbler	Central neotropical migrant	R (0.6)	14	- 1.6 (± 0.3)	0.19
Chestnut-sided Warbler	Central and southern neotropical migrant	C (6.7)	25	- 4.5 (± 0.5)	0.03
Black-throated Green Warbler	Central neotropical migrant	U (1.7)	15	1.0 (± 0.7)	0.30

Table 18. Continued.

Prairie Warbler	Central neotropical migrant	C (7.2)	24	- 9.0 (± 2.0)	0.001
Cerulean Warbler	Southern neotropical migrant	A (12.0)	26	- 1.3 (± 0.7)	0.22
Black-and-White Warbler	Central neotropical migrant	A (15.6)	32	4.8 (± 0.8)	0.03
American Redstart	Central neotropical migrant	A (13.9)	32	6.0 (± 1.0)	0.02
Worm-eating Warbler	Central neotropical migrant	C (9.1)	25	- 1.9 (± 0.5)	0.17
Ovenbird	Central neotropical migrant	A (16.5)	32	- 2.3 (± 0.9)	0.12
Kentucky Warbler	Central neotropical migrant	FC (3.7)	20	- 7.5 (± 0.6)	0.01
Common Yellowthroat	Central neotropical migrant	C (7.3)	27	- 1.3 (± 0.7)	0.22
Hooded Warbler	Central neotropical migrant	A (14.4)	32	- 4.3 (± 1.0)	0.03
Yellow-breasted Chat	Central neotropical migrant	C (7.2)	26	- 3.5 (± 0.8)	0.04
Scarlet Tanager	Southern neotropical migrant	C (10.5)	32	6.1 (± 1.2)	0.02
Northern Cardinal	Permanent resident	A (18.6)	32	- 2.9 (± 0.7)	0.05

Table 18. Continued.

Rose-breasted Grosbeak	Southern neotropical migrant	C (7.0)	23	4.1 (± 0.9)	0.03
Indigo Bunting	Central neotropical migrant	A (25.7)	32	2.4 (± 0.8)	0.06
Eastern Towhee	Permanent resident Temperate migrant	C (10.7)	32	0.95 (± 0.5)	0.33
Chipping Sparrow	Temperate and central neotropical migrant	C (8.9)	32	- 4.9 (± 0.7)	0.03
Field Sparrow	Temperate migrant	C (11.7)	27	- 7.3 (± 0.9)	0.01
Vesper Sparrow	Temperate migrant	U (1.9)	16	- 16.2 (± 1.2)	0.001
Grasshopper Sparrow	Central neotropical migrant	FC (3.5)	20	- 7.9 (± 0.9)	0.01
Song Sparrow	Permanent resident Temperate migrant	A (16.1)	29	- 6.4 (± 1.0)	0.02
Red-winged Blackbird	Temperate migrant	C (9.6)	24	- 8.1 (± 1.3)	0.01
Eastern Meadowlark	Temperate and southern neotropical migrant	FC (3.7)	19	- 8.5 (± 0.8)	0.01
Brown-headed Cowbird	Temperate migrant	U (1.4)	15	- 9.1 (± 1.5)	0.001
Orchard Oriole	Central neotropical migrant	FC (2.2)	15	1.7 (± 1.0)	0.19

Table 18. Continued.

Baltimore Oriole	Central neotropical migrant	R (0.6)	14	- 1.2 (± 0.9)	0.22
American Goldfinch	Permanent resident Temperate migrant	C (11.4)	32	- 7.4 (± 1.3)	0.01

[1] Hall (1983), Rappole et al. 1983, and Ehrlich et al. (1988). [2] Peterjohn et al. 1987. The 32 routes were mainly along narrow contour mines running along forested slopes and ridges.

Figure 9. GIS data enclosed. Six maps for each of three sites (Peachtree Ridge, Highland Mountain, and Whitby).

Table 19. Independent variables included in stepwise multiple regressions of abundances of five species of shrubland birds on contour mines in southern West Virginia.

Species	R^2	Independent Variables[a]
Golden-winged Warbler	0.73	+ edge length (0.15) + elevation (0.14) + slope (0.07).
Chestnut-sided Warbler	0.69	+ elevation (0.22) - canopy cover (0.09) + shrub height (0.03).
Indigo Bunting	0.56	- tree height (0.25) + edge length (0.11) + shrub height (0.05)
Eastern Towhee	0.35	- tree height (0.38) + edge length (0.11) + shrub height (0.06)
Field Sparrow	0.27	+ edge length (0.21) + elevation (0.10) - tree height (0.07).

[a] Independent variables are listed in order in which they were included in the model. All variables listed were significant ($p < 0.05$).

Table 20. Abundance (mean with standard errors in parentheses) of a few selected forest species during 50-m radius point count surveys on historical contour mine (n = 30) and historical MTRVF (n = 12) sites throughout southern West Virginia during the breeding season (June).

	Contour		MTRVF[a]			
Species	Edge	Interior	Edge	Interior	ANOVA Results[b] F	p
Acadian Flycatcher	0.15 (0.04)	0.19 (0.03)	0.15 (0.05)	0.13 (0.03)	2.26	0.09
Black-throated Green Warbler	0.07 (0.02)	0.08 (0.01)	0.03 (0.009)	0.05 (0.01)	2.06	0.13
Blue-headed Vireo	0.11 (0.03) - A	0.12 (0.03) - A	0.03 (0.007) - B	0.04 (0.009) - B	3.90	0.05
Cerulean Warbler	0.25 (0.04) - A	0.28 (0.04) - A	0.06 (0.007) - B	0.04 (0.005) - B	4.78	0.02
Eastern Wood-Pewee	0.16 (0.02) - A, B	0.20 (0.08) - B	0.11 (0.03) - A	0.13 (0.03) - A	3.87	0.05
Great-crested Flycatcher	0.12 (0.01)	0.09 (0.007)	0.10 (0.03)	0.08 (0.04)	2.10	0.12
Kentucky Warbler	0.04 (0.004)	0.06 (0.006)	0.04 (0.003)	0.04 (0.007)	1.19	0.32
Louisiana Waterthrush	0.08 (0.003) - A, B	0.15 (0.02) - C	0.05 (0.009) - A, B	0.10 (0.02) - A	4.06	0.04
Ovenbird	0.22 (0.08) - A	0.30 (0.10) - B	0.15 (0.07) - C	0.20 (0.10) - A	5.13	0.01
Scarlet Tanager	0.20 (0.12)	0.20 (0.09)	0.17 (0.11)	0.19 (0.09)	1.99	0.17
Wood Thrush	0.23 (0.12)	0.25 (0.08)	0.20 (0.11)	0.22 (0.08)	3.82	0.06
Worm-eating Warbler	0.15 (0.05) - A, B	0.18 (0.07) - B	0.11 (0.03) - A	0.11 (0.05) - A	4.10	0.04

[a] Includes partial MTRVFs. [b] One-way ANOVA was used to test for mean abundance differences across habitat types. Means with different letters are significantly different (Duncan s multiple comparisons test).

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Table 21. Guild abundance in edge (shrub/forest) and interior forest plots at Metalton, Raleigh County, West Virginia during the breeding season (June). Data collected from 1996-2000. Values are ± 1 SE for captures per 100 mist-net hours (n = 12 days) and number of birds detected per 300-meter transect (n = 12)[a].

	Nets			Transects		
Guilds	Edge	Interior	p[b]	Edge	Interior	p[b]
Ground-shrub	22.4 ± 3.4	18.9 ± 3.7	0.01	18.0 ± 3.1	16.9 ± 2.7	NS
Trunk-bark	12.3 ± 2.9	13.5 ± 2.7	NS	10.4 ± 2.8	11.5 ± 2.1	NS
Sallier-canopy	25.1 ± 2.8	20.7 ± 3.0	0.01	20.9 ± 2.7	17.7 ± 2.2	0.05

[a] Transect methods were same as those reported for methods of the migration counts on MTRVFs. [b] Mann-Whitney U-test. NS = not significant ($p > 0.05$).

Table 22. Summary of captured birds at TRMO (Metalton contour edges and intact forest) during the breeding season from 1996-2000.

Habitat Group	Captured	Recaptured[a]
Grassland Species	49	12
Shrub	451	181
Woodland	268	86

[a] Does not include multiple recaptures for single birds. Habitats (grassland, shrub, and forest) were sampled equally with the same net hours.

Table 23. Partners in Flight West Virginia Northern Cumberland Plateau priority bird species grouped by habitats and occurrence as either higher on contour or MTRVF in southern West Virginia. The continental population trend from the BBS is shown.

Species			
Forest Interior	Watch List[a]	Higher Numbers in which Forest Edge[b]	Continental Trend[c]
Acadian Flycatcher		Contour	+
Black-throated Green Warbler		Contour	+
Cerulean Warbler	EH	Contour	-*
Eastern Wood-Pewee		Contour	-*
Kentucky Warbler	M	Contour	-*
Louisiana Waterthrush		Contour	+
Ovenbird		Contour	+*
Scarlet Tanager		Contour	-
Summer Tanager		MTRVF	-
Wood Thrush	MH	Contour	-*
Worm-eating Warbler	MH	Contour	+
Yellow-throated Warbler		MTRVF	+
Interior-Edge Species			
American Redstart		Contour	-
Black-and-White Warbler		Contour	+
Blue-gray Gnatcatcher		MTRVF	+*
Carolina Wren		MTRVF	+*
Hooded Warbler		Contour	+
Northern Parula		Contour	+*
Red-bellied Woodpecker		Equal	+*
Yellow-billed Cuckoo		Equal	-*
Yellow-throated Vireo		MTRVF	+*

Table 23. Continued.

Edge Species	Watch List[a]	Higher Numbers in which Forest Edge[b]	Continental Trend[c]
Blue-winged Warbler	M	Contour	+
Brown Thrasher		MTRVF	-*
Common Yellowthroat		MTRVF	-*
Chipping Sparrow		Equal	-
Eastern Towhee			
Field Sparrow		MTRVF	-*
Golden-winged Warbler	EH	Contour	-*
Gray Catbird		Contour	-
Indigo Bunting		MTRVF	-*
Prairie Warbler	M	MTRVF	-*
White-eyed Vireo		Contour	+
Willow Flycatcher		Contour	O
Yellow Warbler		MTRVF	+*
Yellow-breasted Chat		Contour	-*
Grassland Species			
Eastern Meadowlark		MTRVF	-*
Grasshopper Sparrow		MTRVF	-*
Horned Lark		MTRVF	-*
Red-winged Blackbird		MTRVF	-*

[a] Watch List species are identified by Partners in Flight as in need for conservation at the national level (codes, adapted from Hunter et al. 2001 and Carter et al. 1996, 2000; EH = extremely high priority, MH = moderately high priority, M = moderate priority). [b] Taken from data used to compile this report and noted as occurring higher on contour vs. MTRVF or in about equal numbers at both mine types. [C] Continental population trends were taken from Hunter et al. (2001) and the BBS 1966-1999 data (Sauer et al. 2000), and are adapted from Carter et al. (2000) as follows: -* = significant decrease, - = possible decrease, O = trend uncertain, + = stable or possible increase, +* = significant increase.

Appendix 1. Common and scientific names of plants found on edge sampling points.

Common Name	Scientific Name	Habitat G/F	Habitat G/FF	Habitat G/S	Habitat S/FF
Agrimony spp.	*Agrimonia* spp.	X	X	X	X
Alternate-leaf dogwood	*Cornus alternifolia*	X	X	X	X
Giant ragweed	*Ambrosia trifida*	X	X	X	X
American basswood	*Tilia americana*	X	X		X
American beech	*Fagus grandifolia*	X	X		X
American elm	*Ulmus americana*	X	X	X	X
American hazelnut	*Corylus americana*	X	X	X	X
American Holly	*Ilex opaca*	X			X
American sycamore	*Platanus occidentalis*	X	X	X	X
Aster spp.	*Aster* spp.	X	X	X	X
Autumn olive	*Elaeagnus umbellata*	X	X	X	X
Bedstraw spp.	*Galium* spp.	X	X	X	X
Beechdrops	*Epifagus virginiana*	X	X		X
Beggar s-lice stickseed	*Hackelia virginiana*	X	X	X	X
Bicolor lespedeza	*Lespedeza bicolor*	X	X	X	X

Appendix 1. Continued.

Common Name	Scientific Name	Habitat			
		G/F	G/FF	G/S	S/FF
Bigtooth aspen	*Populus grandidentata*	X	X	X	X
Birdsfoot-trefoil	*Lotus corniculatus*	X	X	X	X
Bitternut hickory	*Carya cordiformis*	X	X		X
Black birch	*Betula lenta*	X	X	X	X
Black cherry	*Prunus serotina*	X	X	X	X
Black gum	*Nyssa sylvatica*	X	X	X	X
Blackjack oak	*Quercus marilandica*	X	X	X	X
Black locust	*Robinia pseudo-acacia*	X	X	X	X
Black nightshade	*Solanum americanum*			X	
Black oak	*Quercus velutina*	X	X		X
Black poplar	*Populus nigra*	X	X		X
Black snakeroot	*Sanicula canadensis*	X			
Black willow	*Salix nigra*		X	X	X
Black walnut	*Juglans nigra*	X			X
Bladdernut	*Staphylea trifolia*		X		X
Blueberry	*Vaccinium spp.*	X	X	X	X

Appendix 1. Continued.

Common Name	Scientific Name	Habitat			
		G/F	G/FF	G/S	S/FF
Blue curls	*Trichostema dichotomum*	X	X	X	X
Blue vervain	*Verbena hastata*	X	X	X	X
Box Elder	*Acer negundo*	X	X	X	X
Broad beech fern	*Phegopteris hexagonoptera*	X			X
Broad-leaved cattail	*Typha latifolia*	X	X	X	X
Broomsedge	*Andropogon virginicus*	X	X	X	X
Buffalo-bur	*Solanum rostratum*	X	X	X	X
Buffalonut	*Pyrularia pubera*				X
Buttercup spp.	*Ranunculus* spp.		X	X	
Butternut	*Juglans cinerea*	X	X		X
Carex spp.	*Carex* spp.	X	X	X	X
Catalpa spp.	*Catalpa* spp.	X	X		X
Catnip	*Nepeta cataria*	X	X	X	X
Chestnut oak	*Quercus prinus*	X	X		X
Chicory	*Cichorium intybus*	X	X	X	X
Christmas fern	Polystichum acrostichoides	X			X

Appendix 1. Continued.

Common Name	Scientific Name	Habitat			
		G/F	G/FF	G/S	S/FF
Cicely spp.	*Osmorhiza* spp.	X	X		X
Cinnamon fern	*Osmunda cinnamomea*	X			X
Clover spp.	*Trifolium* spp.	X	X	X	X
Coltsfoot	*Asarum virginicum*	X	X	X	X
Common burdock	*Arctium minus*	X	X	X	X
Common chickweed	*Stellaria media*	X	X	X	X
Common clubmoss	*Lycopodium clavatum*	X	X	X	X
Common dandelion	*Taraxacum officinale*	X	X	X	
Common elderberry	*Sambucus canadensis*	X			
Common greenbrier	*Smilax rotundifolia*	X	X	X	X
Common Joe-Pye weed	*Eupatorium fistulosum*	X	X	X	X
Common mouse-ear chickweed	*Cerastium vulgatum*	X	X	X	X
Common pigweed	*Amaranthus hybridus*	X	X	X	X
Common purslane	*Portulaca oleracea*	X	X	X	X
Common ragweed	*Ambrosia artemisiifolia*	X	X	X	X

Appendix 1. Continued.

Common Name	Scientific Name	Habitat			
		G/F	G/FF	G/S	S/FF
Common teasel	*Dipsacus sylvestris*		X	X	
Common thistle	*Cirsium vulgare*	X	X	X	X
Cottonwood	*Populus deltoides*	X	X		X
Crab apple spp.	*Pyrus* spp.			X	X
Crabgrass	*Digitaria sanguinalis*	X	X	X	X
Crown vetch	*Coronilla varia*	X	X	X	X
Cucumber tree	*Magnolia acuminata*	X	X		X
Cudweed	*Gnaphalium obtusifolium*	X	X	X	X
Curly dock	*Rumex crispus*	X	X	X	X
Cutleaf grapefern	*Botrychium dissectum*	X	X	X	X
Deertongue grass	*Panicum clandestinum*	X	X	X	X
Deptfork pink	*Dianthus armeria*	X	X	X	X
Devilweed	*Lactuca canadensis*	X	X	X	X
Eastern hemlock	*Tsuga canadensis*	X	X		X
Eastern redbud	*Cercis canadensi*	X	X		X
Elephant s-foot	*Elephantopus carolinianus*	X	X	X	X

Appendix 1. Continued.

Common Name	Scientific Name	Habitat			
		G/F	G/FF	G/S	S/FF
English daisy	*Bellis perennis*	X	X	X	X
European black alder	*Alnus glutinosa*	X	X	X	X
Fall phlox	*Phlox paniculata*	X	X	X	X
Fescue spp.	*Festuca spp.*	X	X	X	X
Field cress	*Lepidium campestre*	X	X	X	X
Field pennycress	*Thlaspi arvense*	X	X	X	X
Field sorrel	*Rumex acetosella*	X	X	X	X
Field sow thistle	*Sonchus arvensis*	X	X	X	X
Flame azalea	*Rhododendron calendulaceum*	X	X		X
Flowering dogwood	*Cornus florida*	X	X	X	X
Flowering wintergreen	*Polygala paucifolia*	X	X	X	X
Goldenrod spp.	*Solidago spp.*	X	X	X	X
Greenbrier	*Smilax spp.*	X	X	X	X
Great mullein	*Verbascum thapsus*	X	X	X	X
Great plaintain	*Plantago major*	X	X	X	X
Ground-ivy	*Glechoma hederacea*	X	X	X	X

Appendix 1. Continued.

Common Name	Scientific Name	Habitat			
		G/F	G/FF	G/S	S/FF
Groundpine	*Lycopodium flabelliforme*	X	X		X
Groundpine (tree clubmoss)	*Lycopodium obscurum*	X	X		X
Hairy-body cocklebur	*Xanthium italicum*	X	X	X	X
Hawkweed spp.	*Hieracium spp.*	X	X	X	X
Hawthorn species	*Crataegus spp.*			X	X
Hay-scented fern	*Dennstaedtia punctilobula*	X	X	X	X
Henbit	*Lamium amplexicaule*	X	X	X	
Hercule s club	*Aralia spinosa*				X
Honeyl ocust	*Gleditsia triacanthos*	X			X
Honeysuckle	*Rhododendron spp.*	X	X	X	X
Horse-nettle	*Solanum carolinense*		X		X
Indian strawberry	*Duchesnea indica*	X	X	X	X
Intermediate wood fern	*Dryopteris intermedia*	X			X
Interrupeted fern	*Osmunda claytoniana*	X	X		X
Ironwood	*Carpinus caroliniana*	X	X	X	X
Japanese honeysuckle	*Lonicera japonica*		X	X	X

Appendix 1. Continued.

		Habitat			
Common Name	Scientific Name	G/F	G/FF	G/S	S/FF
Japanese knotweed	*Polygonum cuspidatum*	X	X	X	X
Japanese spiraea	*Spiraea japonica*	X	X	X	X
Jewelweed	*Impatiens pallida*	X	X		X
Jimson weed	*Datura stramonium*	X	X	X	X
Knotweed	*Polygonum spp.*	X	X	X	X
Kudzu	*Pueraria lobata*	X	X	X	X
Laciniate wild teasel	*Dipsacus laciniatus*	X	X	X	X
Lamb s quarters	*Chenopodium album*	X	X	X	X
Large-flowered tickseed	*Coreopsis grandiflora*	X	X	X	X
Little Bluestem	*Andropogon scoparius*	X	X	X	X
Loblolly pine	*Pinus taeda*	X			X
Long-leaved summer bluets	*Houstonia longifolia*	X	X	X	X
Loosestrife spp.	*Lysimachia spp.*	X	X	X	X
Mallow spp.	*Malva spp.*	X	X	X	X
Maple-leaf arrowood	*Viburnum acerifolium*	X	X		X
Maple leaf viburnum	*Viburnum acerifolium*				X

Appendix 1. Continued.

Common Name	Scientific Name	Habitat			
		G/F	G/FF	G/S	S/FF
May-apple	*Podophyllum peltatum*	X	X	X	X
Milkweed spp.	*Asclepias spp.*	X	X	X	X
Mimosa	*Albizia julibrissin*			X	
Mockernut hickory	*Carya tomentosa*	X			X
Moth mullein	*Verbascum blattaria*	X	X	X	X
Mountain laurel	*Kalmia latifolia*	X	X	X	X
Multiflora rose	*Rosa multiflora*	X	X	X	X
Mustard spp.	*Brassica spp.*	X	X	X	X
New York fern	*Thelypteris noveboracensis*	X			X
Oakleaf goosefoot	*Chenopodium glaucum*	X	X	X	X
Ohio buckeye	*Aesculus glabra*	X	X	X	X
Parsnip	*Pastinaca sativa*	X	X	X	X
Partridge berry	*Mitchella repens*	X			
Pasture thistle	*Cirsium pumilum*	X	X	X	X
Pawpaw	*Asimina triloba*	X	X		X
Persimmon	*Diospyros virginiana*	X	X	X	X

Appendix 1. Continued.

Common Name	Scientific Name	Habitat			
		G/F	G/FF	G/S	S/FF
Philadelphia fleabane	*Erigeron philadelphicus*	X	X	X	X
Pignut hickory	*Carya glabra*	X	X		X
Pitch pine	*Pinus rigida*	X	X	X	X
Poison ivy	*Toxicodendron radicans*	X	X	X	X
Pokeweed	*Phytolacca americana*	X	X	X	X
Prickly lettuce	*Lactuca scariola*	X	X	X	X
Princess-tree	*Paulownia tomentosa*	X	X	X	X
Purple dead-nettle	*Lamium purpureum*	X	X	X	
Purple sneezeweed	*Helenium flexuosum*	X	X	X	X
Queen Anne s lace	*Daucus carota*	X	X	X	X
Raspberry/blackberry	*Rubus spp.*	X	X	X	X
Rattlesnake fern	*Botrychium virginianum*				X
Redbud	*Cercis canadensis*	X	X	X	X
Red cedar	*Juniperus virginiana*		X	X	X
Red maple	*Acer rubrum*	X	X	X	X
Red mulberry	*Morus rubra*	X			X

Appendix 1. Continued.

		Habitat			
Common Name	Scientific Name	G/F	G/FF	G/S	S/FF
Red oak	*Quercus rubra*	X	X		X
Red pine	*Pinus resinosa*	X	X	X	X
River birch	*Betula nigra*				X
Rhododendron	*Rhododendron maximum*	X	X		X
Rock spikemoss	*Selaginella rupestris*	X	X	X	X
Rose pink	*Sabatia angularis*			X	X
Sassafras	*Sassafras albidum*	X	X	X	X
Scarlet Oak	*Quercus coccinea*	X	X		X
Scotch pine	*Pinus sylvestris*	X	X	X	X
Serviceberry	*Amelanchier spp.*	X	X		X
Shagbark hickory	*Carya ovata*	X	X		X
Shortleaf pine	*Pinus echinata*	X			X
Small-headed sunflower	*Helianthus microcephalus*	X	X		X
Smooth-body cocklebur	*Xanthium pennsylvanicum*	X	X	X	X
Smooth forked-chickweed	*Paronychia canadensis*	X	X	X	X
Smooth sumac	*Rhus glabra*	X	X	X	X

Appendix 1. Continued.

Common Name	Scientific Name	Habitat			
		G/F	G/FF	G/S	S/FF
Sourwood	*Oxydendrum arboreum*	X	X	X	X
Spicebush	*Lindera benzoin*	X			X
Spotted knapweed	*Centaurea maculosa*		X	X	X
Spreading dogbane	*Apocynum androsaemifolium*	X	X	X	X
Staghorn sumac	*Rhus typhina*	X	X	X	X
Star flower	*Trientalis borealis*		X		X
Stinging nettle	*Urtica dioica*	X	X		X
Strawberry-tomato	*Physalis pruinosa*	X	X	X	X
Striped maple	*Acer pensylvanicum*	X	X		X
Sugar maple	*Acer saccharum*	X	X	X	X
Sweetbrier	*Rosa eglanteria*	X	X	X	X
Sweet fern	*Comptonia peregrina*	X	X	X	X
Sweetgum	*Liquidambar styraciflua*	X	X		
Switch grass	*Panicum virgatum*		X	X	
Tall ironweed	*Vernonia altissima*	X	X	X	X
Tall thistle	*Cirsium altissimum*	X	X	X	X

Appendix 1. Continued.

Common Name	Scientific Name	Habitat G/F	G/FF	G/S	S/FF
Tartanian honeysuckle	*Lonicera tatarica*			X	X
Teaberry	*Gaultheria procumbens*	X	X		X
Thinleaved sunflower	*Helianthus decapetalus*	X	X		X
Timothy	*Phleum pratense*		X	X	
Trailing arbutus	*Epigaea repens*	X	X		X
Tree of heaven	*Ailanthus altissima*	X	X	X	X
Tumbleweed	*Panicum capillare*	X	X	X	X
Umbrella tree	*Magnolia tripetala*	X	X		X
Upland willow	*Salix humilis*			X	X
Vetch spp.	*Vicia spp.*	X	X	X	X
Violet spp.	*Viola spp.*	X	X	X	X
Virginia creeper	*Parthenocissus quinquefolia*	X	X	X	X
Virginia pine	*Pinus virginiana*	X	X	X	X
Virginia strawberry	*Fragaria virginiana*	X	X	X	X
White ash	*Fraxinus americana*	X	X		X
White-flowered leafcup	*Polymnia canadensis*	X	X		X

Appendix 1. Continued.

		Habitat			
Common Name	Scientific Name	G/F	G/FF	G/S	S/FF
White oak	*Quercus alba*	X	X	X	X
White pine	*Pinus strobus*	X	X	X	X
Wild grape	*Vitis spp.*	X	X	X	X
Wild indigo	*Baptisia tinctoria*	X			
Wisteria	*Wisteria frutescens*	X	X	X	X
Witchhazel	*Hamamelis virginiana*	X	X	X	X
Wild geranium	*Geranium maculatum*	X	X	X	X
Wild hydrangea	*Hydrangea arborescens*	X	X		X
Wild rose	*Rosa spp.*	X	X	X	X
Wild sage	*Salvia lyrata*	X	X	X	X
Wild sweet William	*Phlox maculata*	X	X	X	X
Winter cress	*Barbarea vulgaris*	X	X	X	X
Wood sorrel spp.	*Oxalis spp.*	X	X	X	X
Wood tickseed	*Coreopsis major*	X	X	X	X
Yarrow milfoil	*Achillea millefolium*	X	X	X	X
Yellow birch	*Betula alleghaniensis*	X	X	X	X

Appendix 1. Continued.

Common Name	Scientific Name	Habitat			
		G/F	G/FF	G/S	S/FF
Yellow corydalis	*Corydalis flavula*				X
Yellow foxtail	*Setaria glauca*		X	X	
Yellow oak	*Quercus muehlenbergii*	X	X		X
Yellow stargrass	*Hypoxis hirsuta*		X	X	X

Appendix 2. Orders, vernacular names, and scientific names of all bird species observed in this study or typically found in the region (Hall 1983, AOU 2000). Those with an asterisk were not observed on the MTRVF EIS study sites. Refer to Hall (1983) for status (i.e., breeding, migrant, rare visitant or hypothetical) for each species.

Order/Species	Scientific Name	Order/Species	Scientific Name
Order Gaviiformes		Great Blue Heron	*Ardea herodias*
Red-throated Loon *	*Gavia stellata*	Great Egret *	*Casmerodius albus*
Common Loon *	*Gavia immer*	Snowy Egret *	*Egretta thula*
Order Podicepediformes		Little Blue Heron *	*Egretta caerulea*
Pied-billed Grebe	*Podilymbus podiceps*	Cattle Egret *	*Bubulcus ibis*
Horned Grebe *	*Podiceps auritus*	Green Heron	*Butorides striatus*
Red-necked Grebe *	*Podiceps grisegena*	Black-crowned Night-Heron *	*Nycticorax nycticorax*
Eared Grebe *	*Podiceps nigricollis*	Yellow-crowned Night-Heron *	*Nyctanassa violacea*
Order Pelecaniformes		White Ibis *	*Eudocimus albus*
American White Pelican *	*Pelecanus erythrorhynchos*	Wood Stork *	*Mycteria americana*
Great Cormorant *	*Phalacrocorax carbo*	**Order Anseriformes**	
Double-crested Cormorant *	*Phalacrocorax auritus*	Tundra Swan *	*Cygnus columbianus*
Order Ciconiiformes		Trumpeter Swan *	*Cygnus buccinator*
American Bittern	*Botaurus lentiginosus*	Mute Swan *	*Cygnus olor*
Least Bittern *	*Ixobrychus exilis*	Greater White-fronted Goose *	*Anser albifrons*

Appendix 2. Continued.

Order/Species	Scientific Name	Order/Species	Scientific Name
Snow Goose *	*Chen caerulescens*	Lesser Scaup *	*Aythya affinis*
Brant *	*Branta bernicla*	Common Goldeneye *	*Bucephala clangula*
Canada Goose	*Branta canadensis*	Bufflehead	*Bucephala albeola*
Wood Duck	*Aix sponsa*	Hooded Merganser	*Lophodytes cucullatus*
Green-winged Teal	*Anas crecca*	Common Merganser *	*Mergus merganser*
American Black Duck	*Anas rubripes*	Red-breasted Merganser *	*Mergus serrator*
Mallard	*Anas platyrhynchos*	Ruddy Duck *	*Oxyura jamaicensis*
Northern Pintail *	*Anas acuta*	King Eider *	*Somateria spectabilis*
Blue-winged Teal *	*Anas discors*	Harlequin Duck *	*Histrionicus histrionicus*
Northern Shoveler *	*Anas clypeata*	Long-tailed Duck *	*Clangula hyemalis*
Gadwall *	*Anas strepera*	Black Scoter *	*Melanitta nigra*
Eurasian Wigeon *	*Anas penelope*	Surf Scoter *	*Melanitta perspicillata*
American Wigeon *	*Anas americana*	White-winged Scoter *	*Melanitta fusca*
Canvasback *	*Aythya valisneria*	**Order Falconiformes**	
Redhead *	*Aythya americana*	Black Vulture *	*Coragyps atratus*
Ring-necked Duck *	*Aythya collaris*	Turkey Vulture	*Cathartes aura*
Greater Scaup *	*Aythya marila*	Osprey *	*Pandion haliaeetus*

Appendix 2. Continued.

Order/Species	Scientific Name	Order/Species	Scientific Name
American Swallow-tailed Kite *	*Elanoides forficatus*	Ruffed Grouse	*Bonasa umbellus*
Bald Eagle *	*Haliaeetus leucocephalus*	Wild Turkey	*Meleagris gallopavo*
Golden Eagle	*Aquila chrysaetos*	Northern Bobwhite	*Colinus virginianus*
Northern Harrier	*Circus cyaneus*	**Order Gruiformes**	
Sharp-shinned Hawk	*Accipiter striatus*	Yellow Rail *	*Coturnicops noveboracensis*
Cooper s Hawk	*Accipiter cooperii*	Black Rail *	*Laterallus jamaicensis*
Northern Goshawk *	*Accipiter gentilis*	Clapper Rail *	*Rallus longirostris*
Red-shouldered hawk	*Buteo lineatus*	King Rail	*Rallus elegans*
Broad-winged Hawk	*Buteo platypterus*	Virginia Rail *	*Rallus limicola*
Red-tailed Hawk	*Buteo jamaicensis*	Sora *	*Porzana carolina*
Swanson s Hawk *	*Buteo swainsonii*	Purple Gallinule *	*Porphyrula martinica*
Rough-legged Hawk	*Buteo lagopus*	Common Moorhen *	*Gallinula chloropus*
American Kestrel	*Falco sparverius*	American Coot	*Fulica americana*
Merlin	*Falco columarius*	Sandhill Crane *	*Grus canadensis*
Peregrine Falcon	*Falco peregrinus*	**Order Charadriiformes**	
Order Galliformes		American Golden-plover *	*Pluvialis dominica*
Ring-necked Pheasant	*Phasianus colchicus*	Black-bellied Plover *	*Pluvialis squatarola*

Appendix 2. Continued.

Order/Species	**Scientific Name**	**Order/Species**	**Scientific Name**
Piping Plover *	*Charadrius melodus*	Baird s Sandpiper *	*Calidris bairdii*
Semipalmated Plover *	*Charadrius semipalmatus*	Pectoral Sandpiper *	*Calidris melanotos*
Killdeer	*Charadrius vociferus*	Dunlin *	*Calidris alpina*
American Avocet *	*Recurvirostra americana*	Stilt Sandpiper *	*Calidris himantopus*
Greater Yellowlegs	*Tringa melanoleuca*	Buff-breasted Sandpiper *	*Tryngites subruficollis*
Lesser Yellowlegs	*Tringa flavipes*	Short-billed Dowitcher *	*Limnodromus griseus*
Solitary Sandpiper	*Tringa solitaria*	Common Snipe	*Gallinago galliango*
Willet *	*Catoptrophorus semipalmatus*	American Woodcock	*Scolopax minor*
Spotted Sandpiper	*Actitis macularia*	Wilson s Phalarope *	*Phalaropus tricolor*
Upland Sandpiper *	*Bartramia longicauda*	Red-necked Phalarope *	*Phalaropus lobatus*
Whimbrel *	*Numenius phaeopus*	Red Phalarope *	*Phalaropus fulicaria*
Hudsonian Godwit *	*Limosa haemastica*	Parasitic Jaeger *	*Stercorarius parasticus*
Ruddy Turnstone *	*Arenia interpres*	Laughing Gull *	*Larus atricilla*
Sanderling *	*Calidrus alba*	Bonaparte s Gull *	*Larus philadelphia*
Semipalmated Sandpiper *	*Calidris pusilla*	Ring-billed Gull	*Larus delawarensis*
Western Sandpiper *	*Calidris mauri*	Herring Gull	*Larus argentatus*
Least Sandpiper *	*Calidris minutilla*	Greater Black-backed Gull *	*Larus marinus*
White-rumped Sandpiper *	*Calidris fuscicollis*	Black-legged Kittiwake *	*Rissa tridactyla*

Appendix 2. Continued.

Order/Species	Scientific Name	Order/Species	Scientific Name
Caspian Tern *	*Sterna caspia*	Long-eared Owl *	*Asio otus*
Common Tern *	*Sterna hirundo*	Short-eared Owl *	*Asio flammeus*
Forster s Tern *	*Sterna forsteri*	Northern Saw-whet Owl *	*Aegolius acadicus*
Least Tern *	*Sterna albifrons*	**Order Caprimulgiformes**	
Sooty Tern *	*Sterna fuscata*	Common Nighthawk	*Chordeiles minor*
Black Tern *	*Chlidonias niger*	Chuck-will s-widow *	*Caprimulgus carolinensis*
Order Columbiformes		Whip-poor-will	*Caprimulgus vociferus*
Rock Dove	*Columba livia*	**Order Apodiformes**	
Mourning Dove	*Zenaida macroura*	Chimney Swift	*Chaetura pelagica*
Order Cuculiformes		Ruby-throated Hummingbird	*Archilocus colubris*
Black-billed Cuckoo	*Coccyzus erythropthalmus*	**Order Coraciiformes**	
Yellow-billed Cuckoo	*Coccyzus americanus*	Belted Kingfisher	*Ceryle torquata*
Order Strigiformes		**Order Piciformes**	
Barn Owl *	*Tyto alba*	Red-headed Woodpecker	*Melanerpes erythrocephalus*
Eastern Screech-Owl	*Otus asio*	Red-bellied Woodpecker	*Melanerpes carolinus*
Great Horned Owl	*Bubo virginianus*	Downy Woodpecker	*Picoides pubescens*
Snowy Owl *	*Nyctea scandiaca*	Hairy Woodpecker	*Picoides villosus*
Barred Owl	*Strix varia*	Yellow-bellied Sapsucker	*Sphyrapicus varius*

Appendix 2. Continued.

Order/Species	Scientific Name	Order/Species	Scientific Name
Northern Flicker	*Colaptes auratus*	Purple Martin	*Progne subis*
Pileated Woodpecker	*Dryocopus pileatus*	Tree Swallow	*Tachycineta bicolor*
Black-backed Woodpecker *	*Picoides arcticus*	Northern Rough-winged Swallow	*Stelgidopteryx ruficollis*
Order Passeriformes		Bank Swallow	*Riparia riparia*
Olive-sided Flycatcher *	*Contopus borealis*	Cliff Swallow	*Petrochelidon pyrrhonota*
Eastern Wood-Pewee	*Contopus virens*	Barn Swallow	*Hirundo rustica*
Yellow-bellied Flycatcher *	*Empidonax flaviventris*	Blue Jay	*Cyanocitta cristata*
Acadian Flycatcher	*Empidonax virescens*	Black-billed Magpie *	*Pica pica*
Alder Flycatcher *	*Empidonax alnorum*	American Crow	*Corvus brachyrhynchos*
Willow Flycatcher	*Empidonax traillii*	Fish Crow *	*Corvus ossifragus*
Least Flycatcher	*Empidonax minimus*	Common Raven	*Corvus corax*
Eastern Phoebe	*Sayornis phoebe*	Black-capped Chickadee	*Poecile atricapillus*
Vermillion Flycatcher *	*Pyrocephalus rubinus*	Carolina Chickadee	*Poecile carolinensis*
Great Crested Flycatcher	*Myiarchus crinitus*	Boreal Chickadee *	*Poecile hudsonicus*
Western Kingbird *	*Tyrannus verticalis*	Tufted Titmouse	*Baeolophus bicolor*
Eastern Kingbird	*Tyrannus tyrannus*	Red-breasted Nuthatch *	*Sitta canadensis*
Scissor-tailed Flycatcher *	*Tyrannus forficatus*	White-breasted Nuthatch	*Sitta carolinensis*
Horned Lark	*Eremophila alpestris*	Brown Creeper	*Certhia americana*

Appendix 2. Continued.

Order/Species	Scientific Name	Order/Species	Scientific Name
Carolina Wren	*Thryothorus ludovicianus*	Brown Thrasher	*Toxostoma rufum*
Bewick s Wren *	*Thryomanes bewickii*	American Pipit	*Anthus spinoletta*
House Wren	*Troglodytes aedon*	Bohemian Waxwing *	*Bombycilla garrulus*
Winter Wren	*Troglodytes troglodytes*	Cedar Waxwing	*Bombycilla cedrorum*
Sedge Wren *	*Cistothorus platensis*	Northern Shrike *	*Lanius excubitor*
Marsh Wren *	*Cistothorus palustris*	Loggerhead Shrike *	*Lanius ludovicianus*
Golden-crowned Kinglet	*Regulus satrapa*	European Starling	*Sturnus vulgaris*
Ruby-crowned Kinglet	*Regulus calendula*	White-eyed Vireo	*Vireo griseus*
Blue-gray Gnatcatcher	*Polioptila caerulea*	Blue-headed Vireo	*Vireo solitarius*
Eastern Bluebird	*Sialia sialis*	Warbling Vireo	*Vireo gilvus*
Veery *	*Catharus fuscescens*	Yellow-throated Vireo	*Vireo flavifrons*
Gray-cheeked Thrush *	*Catharus minimus*	Philadelphia Vireo *	*Vireo philadelphicus*
Swainson s Thrush	*Catharus ustulatus*	Red-eyed Vireo	*Vireo olivaceus*
Hermit Thrush	*Catharus guttatus*	Blue-winged Warbler	*Vermivora pinus*
Wood Thrush	*Hylocichla fuscescens*	Golden-winged Warbler	*Vermivora chrysoptera*
American Robin	*Turdus migratorius*	Tennessee Warbler	*Vermivora peregrina*
Gray Catbird	*Dumetella carolinensis*	Orange-crowned Warbler *	*Vermivora celata*
Northern Mockingbird	*Mimus polyglottos*	Nashville Warbler	*Vermivora ruficapilla*

Appendix 2. Continued.

Order/Species	Scientific Name	Order/Species	Scientific Name
Northern Parula	*Parula americana*	Black-and-white Warbler	*Mniotilta varia*
Yellow Warbler	*Dendroica petechia*	American Redstart	*Setophaga ruticilla*
Chestnut-sided Warbler	*Dendroica pensylvanica*	Prothonotary Warbler *	*Protonotaria citrea*
Magnolia Warbler	*Dendroica magnolia*	Worm-eating Warbler	*Helmitheros vermivorus*
Cape May Warbler	*Dendroica tigrina*	Swainson s Warbler *	*Limnothlypis swainsonii*
Black-throated Blue Warbler	*Dendroica caerulescens*	Ovenbird	*Seiurus aurocapillus*
Yellow-rumped Warbler *	*Dendroica coronata*	Northern Waterthrush *	*Seiurus noveboracensis*
Black-throated Green Warbler	*Dendroica virens*	Louisiana Waterthrush	*Seiurus motacilla*
Blackburnian Warbler	*Dendroica fusca*	Kentucky Warbler	*Oporornis formosus*
Yellow-throated Warbler	*Dendroica dominica*	Connecticut Warbler *	*Oporornis agilis*
Sutton s Warbler *	*Dendroica potomac*	Mourning Warbler	*Oporornis philadelphia*
Pine Warbler	*Dendroica pinus*	Common Yellowthroat	*Geothlypis trichas*
Kirtland s Warbler *	*Dendroica kirtlandii*	Hooded Warbler	*Wilsonia citrina*
Prairie Warbler	*Dendroica discolor*	Wilson s Warbler *	*Wilsonia pusilla*
Palm Warbler	*Dendroica palmarum*	Canada Warbler	*Wilsonia canadensis*
Bay-breasted Warbler	*Dendroica castanea*	Yellow-breasted Chat	*Icteria virens*
Blackpoll Warbler	*Dendroica striata*	Summer Tanager	*Piranga rubra*
Cerulean Warbler	*Dendroica cerulea*	Scarlet Tanager	*Piranga olivacea*

Appendix 2. Continued.

Order/Species	Scientific Name	Order/Species	Scientific Name
Western Tanager *	*Piranga ludoviciana*	Lark Bunting *	*Calamospiza melanocorys*
Northern Cardinal	*Cardinalis cardinalis*	Savannah Sparrow	*Passerculus sandwichensis*
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	Grasshopper Sparrow	*Ammodramus savannarum*
Blue-headed Grosbeak *	*Pheuticus melanocephalus*	Henslow s Sparrow *	*Ammodramus henslowii*
Blue Grosbeak	*Guiraca caerulea*	LeConte s Sparrow *	*Ammodramus leconteii*
Indigo Bunting	*Passerina cyanea*	Sharp-tailed Sparrow *	*Ammodramus caudacutus*
Painted Bunting *	*Passerina ciris*	Fox Sparrow *	*Passerella iliaca*
Dickcissel	*Spiza americana*	Song Sparrow	*Melospiza melodia*
Green-tailed Towhee *	*Pipilo chlorurus*	Lincoln s Sparrow	*Melospiza lincolnii*
Eastern Towhee	*Pipilo erythrophthalmus*	Swamp Sparrow	*Melospiza georgiana*
Brown Towhee *	*Pipilo fuscus*	White-throated Sparrow	*Zonotrichia albicollis*
Bachman s Sparrow *	*Aimophila aestivalis*	White-crowned Sparrow	*Zonotrichia leucophrys*
American Tree Sparrow	*Spizella arborea*	Harris Sparrow *	*Zonotrichia querula*
Chipping Sparrow	*Spizella passerina*	Dark-eyed Junco	*Junco hyemalis*
Clay-colored Sparrow *	*Spizella pallida*	Lapland Lonspur *	*Calcarius lapponicus*
Field Sparrow	*Spizella pusilla*	Snow Bunting *	*Plectrophenax nivalis*
Vesper Sparrow	*Pooecetes gramineus*	Bobolink	*Dolichonyx oryzivorus*
Lark Sparrow *	*Chondestes grammacus*	Red-winged Blackbird	*Agelaius phoeniceus*

Appendix 2. Continued.

Order/Species	Scientific Name	Order/Species	Scientific Name
Eastern Meadowlark	*Sturnella magna*	Purple Finch	*Carpodacus purpureus*
Western Meadowlark *	*Sturnella neglecta*	House Finch	*Carpodacus mexicanus*
Yellow-headed Blackbird *	*Xanthocephalus xanthocephalus*	Red Crossbill *	*Loxia curvirostra*
Rusty Blackbird *	*Euphagus carolinus*	White-winged Crossbill *	*Loxia leucoptera*
Brewer s Blackbird	*Euphagus cyanocephalus*	Common Redpoll *	*Carduelis flammea*
Common Grackle	*Quiscalus quiscula*	Pine Siskin *	*Carduelis pinus*
Brown-headed Cowbird	*Molothrus ater*	American Goldfinch	*Carduelis tristis*
Orchard Oriole	*Icterus spurius*	Evening Grosbeak *	*Coccothraustes vespertina*
Baltimore Oriole	*Icterus galbula*	House Sparrow	*Passer domesticus*
Pine Grosbeak *	*Pinicola enucleator*		

EIS REPORT

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